www.instec2022.com

# INSTEC-2022

## International Nuclear Sciences and Technologies Conference

## 19-22 October 2022

Pine Bay Holiday Resort Kuşadası, AYDIN - TURKEY

## BOOK OF ABSTRACTS

Organization Secretariat

MOTTO
www.motto.tc

+90 232 446 06 10
info@motto.tc

## CONTENTS

## INVITATION

Dear Colleagues,

We kindly invite you to the International Nuclear Sciences and Technologies Conference (INSTEC-22) organized by Ege University Institute of Nuclear Sciences with the support of the Turkish Energy, Nuclear and Mineral Research Agency (TENMAK), which will take place on October 19-22, 2022 in Kuşadası, Turkey.

National Nuclear Sciences and Technologies Conference (NBTK) was held by Ege University (1980), Turkish Atomic Energy Authority (ÇNAEM) (1984), Istanbul Technical University (1989), Atatürk University (1990), Ege University (1991), Uludağ University (1993), Istanbul Technical University (1996), Erciyes University (2003), Ege University (2005), Muğla University (2009) and Ege University (2016).

International Nuclear Sciences and Technologies Conference (INSTEC-22) will be organized internationally for the first time this year which intends to bring together world leading and junior scientists from the different branches of nuclear field research communities.

The goal of the International Nuclear Sciences and Technologies Conference, which has a history of 42 years; academicians and experts working in universities and research institutions in the fields of basic nuclear sciences, nuclear technologies, and their applications come together to share scientific and technological knowledge, evaluate research results and provide an environment for discussion, as well as strengthening relations and increasing friendships between researchers within the framework of conference social events and providing continuity by establishing the background for joint scientific studies.

More detailed information is provided on the official website (www.instec2022.com).

We will be honored with your participation and contribution to the International Nuclear Sciences and Technologies Conference which will be a great opportunity to meet with scientists from different countries around the world and sharing new and exciting results in Nuclear field.

We are looking forward to seeing you in Kusadasi-TURKEY in 19-22 October 2022.

**Prof. Dr. Abdulkadir BALIKÇI**
Turkish Energy, Nuclear and
Mineral Research Agency

**Prof. Dr. Sabriye YUŞAN**
Ege University
Institute of Nuclear Sciences

## COMMITTEES

### Head of Organizing Committee

Sabriye YUŞAN

### Organizing Committee

Ayfer YURT KILÇAR
Banu YOHO
Berkan ÇETİNKAYA
Caner TAŞKÖPRÜ
Çiğdem İÇHEDEF
Doğukan Alkım TÜRKÖZÜ
Elçin EKDAL KARALI
İkbal Gözde KAPTANOĞLU
Şule AYTAŞ
Ümit H. KAYNAR

### Scientific Committee

| | |
|---|---|
| A. Rachid CHAIBOU YACOUBA | Agadez University Agadez, NIGER |
| Aysun UĞUR GÖRGÜN | Ege University, TURKEY |
| Berkay CAMGÖZ | Ege University, TURKEY) |
| Boguslaw MICHALIK | Central Mining Institute (GIG), POLAND |
| Cem GÖK | Pamukkale University, TURKEY |
| Dilek ŞOLPAN ÖZBAY | Hacettepe University, TURKEY |
| Dimitar TONEV | Bulgarian Academy of Sciences BAS INRNE BULGARIA |
| Durmuş ÖZDEMİR | Izmir Institute of Technology IYTE, TURKEY |
| Dursun SARAYDIN | Cumhuriyet University, TURKEY |
| Emin İlker MEDİNE | Ege University, TURKEY |
| Erhan AKSU | TENMAK-NÜKEN, TURKEY |
| F. Zümrüt MÜFTÜLER BİBER | Ege University, TURKEY |
| Fabio MANTOVANI | University of Ferrara, ITALY |
| Fatma YURT ONARAN | Ege University, TURKEY |
| Fotini NOLI | Aristotle University of Thessaloniki, GREECE |
| Galina LUJANIENE | Center of Physical Sciences and Technology, LITHUANIA |
| Gregory DELECAUT | IRE ELiT, BELGIUM |
| Günseli YAPRAK | Ege University, TURKEY |
| Hüseyin ENGİNAR | Afyon Kocatepe University, TURKEY |
| Islam MUSTAFAYEV | Azerbaijan Academy of Sciences, AZERBAIJAN |
| İlker SERT | Ege University, TURKEY |
| İskender A. REYHANCAN | İstanbul Teknik University, TURKEY |
| Leon FUCKS | Institute of Nuclear Chemistry and Technology, POLAND |
| Kübra DURKAN | Ege University, TURKEY |
| Madis KIISK | University of Tartu, ESTONIA |
| Mahmoud A. A. ASLANI | Ege University, TURKEY |
| Mark BASKARAN | Wayne State University, USA |

| | |
|---|---|
| Mehmet ERKEK | Turkish Medical Radiotechnology Society, TURKEY |
| Melek MERDİVAN | Dokuz Eylul University, TURKEY |
| Meryem SEFERİNOĞLU | Sinop University, TURKEY |
| Mustafa TOPAKSU | Çukurova University, TURKEY |
| Mutlu İÇHEDEF | Ege University, TURKEY |
| Müslim Murat SAÇ | Ege University, TURKEY |
| Müşerref ARDA KESGiN | Ege University, TURKEY |
| Nalan KABAY | Ege University, TURKEY |
| Nina NIKOLAVA | Bulgarian Academy of Sciences BAS INRNE, BULGARIA |
| Nurdoğan CAN | Jazan University, Kingdom of Saudi Arabia |
| Pavel POVINEC | Comenius University, SLOVAKIA |
| Ramazan DONAT | Pamukkale University, TURKEY |
| Rasim IPEK | Ege University, TURKEY |
| Saif UDDIN | Kuwait Institute for Scientific Research, KUWAIT |
| Santosh KUMAR SAR | Bhilai Institute of Technology, INDIA |
| Sema ERENTÜRK | İstanbul Teknik University, TURKEY |
| Serap TEKSÖZ | Ege University, TURKEY |
| Serkan AKKOYUN | Cumhuriyet University, TURKEY |
| Serpil AKÖZCAN | Kırklareli University, TURKEY |
| Sevilay HACIYAKUPOĞLU | İstanbul Teknik University, TURKEY |
| Süleyman İNAN | Ege University, TURKEY |
| Şenol SERT | Ege University, TURKEY |
| Tibor KOVACS | Institute of Radiochemistry and Radioeceology, HUNGARY |
| Trifce SANDEV | Macedonian Academy of Sciences and Arts, Skopje, MACEDONIA |
| Tuncay BAYRAM | Karadeniz Teknik University, TURKEY |
| Türkan ERTAY | Dokuz Eylül University, TURKEY |
| Uğur AVCIBAŞI | Celal Bayar University, TURKEY |
| Ümran HİÇSÖNMEZ | Celal Bayar University, TURKEY |
| Yüksel ALTAŞ | Ege University, TURKEY |

**SPONSORS**


FİGES


Blabmarket
Online Alışveriş
WWW.BLABMARKET.COM


affidea


TÜBİTAK

## TOPICS

- Environmental Radioactivity
- Nanotechnologies in Nuclear Applications
- Nuclear Applications
- Nuclear Energy
- Nuclear Medicine
- Nuclear Physics
- Nuclear Safety
- Nuclear Technologies
- Radiation Detectors
- Radiation Protection and Safety
- Radioanalytical Techniques
- Radiobiology
- Radiochemistry
- Radiopharmaceuticals

## ABBREVIATIONS

IL-: Invited Lecture

O-: Oral Presentation

P-: Poster Presentation

# INVITED LECTURES

# IL-1 Bark Functionalized Magnetite Bio-Composite as Promising Adsorbent for Adsorptive Extraction of U(VI) From Water

Poonam Deshmukh[1], **Santosh Kumar Sar[1]**
[1]Bhilai Institute of Technology, Durg, INDIA

Water pollution from heavy metal particles and natural squanders is a major global concern. Magnetite nano composites appear to be effective adsorbents for the removal of bothersome metal particles from water. They are also promising for water cleaning because their physiochemical properties, low-cost technique, and ease of recovery in the presence of an attractive field. The aim of this study is look into the potential applications of plant-mediated magnetite bio composite adsorbents in water sanitization. The magnetite assisted plant mediated new magnetic bio composite was made in this study employing the tree bark of the phyllanthus family plant i,e. Amla, and a chemical co precipitation technique. The composite was successfully investigated utilizing FTIR, FE-SEM, XRD, and EDS. U (VI) extraction from aqueous solutions. The findings revealed that the pH of the solution, contact time, and initial concentration all had a substantial impact on adsorption capabilities. A higher pH (pH =7) encourages more U(VI) removal. Temperature also influences adsorption. Adsorption isotherm followed the Langmuir model among all the applied models i,e. Freundlich and Temkin isotherm The greatest adsorption capacity recorded was 121.95 mg/g, and a two-stage kinetic pattern was seen during the adsorption of uranium (VI): rather quick initial adsorption in a few minutes, followed by a large period of slower uptake. As the temperature is raised, the uranium (VI) loading per unit weight of the sorbent increased. The uranium adsorption by magnetite was efficient, with an equilibrium period of 40 minutes for uranium (VI) adsorption. To analyze the kinetic data, the pseudo-1st order kinetic model, pseudo 2nd order model, as well as intra particle diffusion model was performed, but the pseudo 2nd order kinetic performed the best. The thermodynamic parameter $\Delta G^0$ was calculated, and uranium (VI) adsorption was validated by the negative $\Delta G^0$ values at various temperatures, indicating that the adsorption mechanism was spontaneous.

**Keywords:** Uranium (VI), Magnetite, Extraction, Nano Bio-composite, Aqueous phase

# IL-2 Polonium Turnaround in the Environment: Risks and Dose Implications

**Saif Uddin**[1], Aysun Gorgun[2], Montaha Behbehani[1]
[1]Kuwait Institute for Scientific Research, KISR, KUWAIT
[2]Ege University, Izmir-TÜRKİYE

Polonium-210 being a highly radiotoxic isotope, is considered a significant contributor of radiation dose to seafood consumers. A significant volume of literature exists on levels of polonium in different marine environmental matrixes and the dose to seafood consumers. However, much less emphasis has been paid towards atmospheric $^{210}$Po and the inhalation dose to humans. This perspective seeks to kindle discussion among interested research groups to consider a comprehensive approach towards assessing radiation dose from $^{210}$Po ingestion and inhalation. We have conducted several experiments and have demonstrated that there are often significant losses of $^{210}$Po due to the cooking of the seafood. $^{210}$Po concentration were 14 to 58% less in cooked seafood compared to the uncooked samples, suggesting the need to re-examine how committed effective doses (CEDs) are best calculated for seafood consuming populations considering that most populations consume fish and shellfish cooked. The levels of $^{210}$Po in aerosol samples were assessed in different inhalable and respirable fractions. $^{210}$Po concentrations were highest in the fine fraction (PM0.39- 2.5) across all sampling stations throughout the year. The highest concentrations in all the size fractions were measured downwind of the Industrial site that houses oil refineries, cement factory, and some other industries, including a Power and Desalination Plant. 91% of the aerosol load was in PM0.39 – 2.5 µm aerosol fraction. The $^{210}$Po/$^{210}$Pb activity concentration ratios in aerosols were stable around the year, and averaged 1.5 (range 1.2 – 1.9), much above typical activity concentration ratios of these radionuclides in unmodified (background) aerosols, with Po/Pb <0.1. The aerosol enrichment in $^{210}$Po likely originated from the oil industry, specifically by gas flaring and oil refining in the Gulf region. Radionuclide analysis in organic and inorganic components of aerosols showed that $^{210}$Po concentration in the organic component was one order of magnitude higher than $^{210}$Po concentration in the inorganic component, contrasting with $^{210}$Pb that displayed similar concentrations in organic and inorganic aerosol components. The atmospheric $^{210}$Po concentration becomes more relevant in light of the recent forest fires in Europe that can considerably obliterate the $^{210}$Po/$^{210}$Pb ratio.

**Keywords:** Ingestion, Inhalation, Cooking losses, Organic partitioning

## IL-3 Research and Development Studies of TENMAK Proton Accelerator Facility

**İsmail Boztosun[1]**
**on behalf of Proton Accelerator Facility Staff**

[1]TENMAK - Turkish Energy, Nuclear and Mineral Research Agency, Proton Accelerator Facility at NÜKEN Saray, Ankara/TÜRKIYE

In the first part of this talk, TENMAK - Turkish Energy, Nuclear and Mineral Research Agency Proton Accelerator Facility located at Saray in Ankara-Türkiye will be briefly introduced. In our facility, the cyclotron provides the highest proton energy application in the region with the solid, liquid, gas and R&D target systems. The details of the radiopharmaceuticals produced at PAF will be outlined. The productions in the classified areas and quality control tests ensure the European Pharmacopoeia specifications according the Good Manufacturing Practices, GMP. At the end of the talk, the reserach and product development studies ranging from next generation radioisotopes to industrial applications will be discussed.

## IL-4 Unusual Thermoluminescence Behaviour for Rare Earth Doped Phosphors and its Possible Dosimetric Applications

**Nurdogan Can**[1]

[1] Department of Physics, College of Science, Jazan University, P.O. Box. 114, Jazan 45142, KINGDOM OF SAUDI ARABIA

Thermoluminescence (TL) dosimetry can be used to measure the amount of radiation exposure a material has been subjected to. This is useful for understanding the effects of radiation on materials and for determining the safety of materials that will be used in high-radiation environments. TL glow-curve analysis methods have been useful in studying the behaviour of trapped electrons and the activation energy of the corresponding electrons. Such methods include the Chen's Peak shape method, the Initial Rise and the Variable Heating Rate method. Contrary to expectations, recently produced new phosphors doped with different rare earth elements (e.g. $Ca_3Y_2B_4O_{12}$:Sm, $ZnB_2O_4$:Gd) showed a different behaviour with heating rate. The luminescence intensity of both the total and individual glow peaks increased with the heating rate throughout the TL experiments. This unusual TL glow peak pattern was discussed using the Mandowski model of semi-localized transitions. The kinetic properties of both prominent glow peaks were determined using various analysis techniques, including variable heating rate, initial rise (IR) using the $T_M$-$T_{stop}$ method and the fractional glow technique (FGT), and computerized glow curve deconvolution (GCD). $Ca_3Y_2B_4O_{12}$:$Sm^{3+}$ and $ZnB_2O_4$:$Gd^{3+}$ phosphors have great potential for use as high temperature dosimetric materials and for environmental monitoring of beta irradiation.

**Keywords:** TL dosimetry, anomalous behaviour, rare earths, kinetic parameters

### References

[1] J. Hakami, M. Oglakci, Z.G. Portakal-Ucar, M. Sonsuz, U.H. Kaynar, M. Ayvacikli, M. Topaksu, N. Can, Samarium doped Ca3Y2B4O12 phosphor prepared by combustion method: Anomalous heating rate effect, dosimetric features, and TL kinetic analyses, Journal of Luminescence, 251 (2022) 119200

[2] S. Atasoz, M. Topaksu, G. Souadi, N. Can, Anomalous heating rate dependence and analyses of thermoluminescence glow curves in Gd doped ZnB2O4 phosphors, Journal of Luminescence, 246 (2022) 118838

## IL-5 Radiotheranostics: A Bridge Through Radiochemistry to Nuclear Medicine

**Perihan Ünak**[1]
[1]Ege University, Institute of Nuclear Sciences, 35100 Bornova Izmir, TÜRKİYE

Within the framework of "personalized medicine", radionuclides with both imaging and therapeutic properties, but working with the same chemistry but showing different decay properties, have received a lot of attention recently, enabling personalized tuning of radiation properties to optimize efficiency for medical care or specific patient groups. The theranostic is derived from the words diagnostic and therapeutic and means that it includes diagnosis and therapy together. Theranostics contain more than one component for the benefit of the patient for personalized therapy. The components involved in diagnosis and therapy in theranostics can be nanoparticles (NP). In current systems, many kinds of nanoparticles can be constituent for theranostics both for imaging and therapy. Besides development of the systems that perform multiple imaging simultaneously, such as SPECT/CT or SPECT/MRI and PET/MRI is possible.

When nanoparticles labeled with radionuclides used in Nuclear Medicine, which have the same chemical properties but different decay patterns, are combined with appropriate therapeutics, theranostic probes that can be used for imaging and therapy at the same time can be created. This presentation will focus on the contribution of radionuclides, which have the same chemical properties but different decay properties, to the theranostic potential when combined with nanoparticular systems.

This presentation will focus on the contribution of radiochemistry to theranostics.

**Acknowledgment**

This work was supported financially by TUBITAK Project No218S749. Author thank to TUBITAK for the support.

## IL-6 Integrating Nanomedicine and Imaging: From Bench to Bedside!

**Omer Aras**[1]
[1]Memorial Sloan Kettering Cancer Center, 1275 York Avenue, New York, NY 10065, USA

Molecular imaging and targeted drug delivery are important parts of personalized medicine, which is the way of the future for taking care of patients. Nanoplatforms have the potential to find, diagnose, and treat diseases early and in a way that is unique to each person. They are used in every biomedical imaging modality. In addition, theranostic applications are made possible by putting targeting ligands, imaging agents, and therapeutics into the nanoplatform as well. Here, this presentation aims to discuss the recent developments in labeling cell-specific imaging probes and nanomedicines, how imaging studies are directing the development of nanomedicines, and the role that imaging will play in the future of nanomedicines.

## IL-7 Short Range Particles Emitters (α and Auger Electrons) in Radionuclide Therapy

**Aleksander Bilewicz**[1]
[1]Institute of Nuclear Chemistry and Technology, Dorodna 16, 03-195 Warsaw, POLAND

Currently, in nuclear medicine there is a huge demand for radiopharmaceuticals showing a therapeutic effect for small neoplastic lesions spread over a large area of tissue, cancer metastases or tumours at an early stage of development. They would complement the already existing radiopharmaceuticals based on $\beta^-$ emitters ($^{90}$Y, $^{188}$Re, $^{131}$I, $^{177}$Lu,), used for radiotherapy of solid tumours. These conditions may be met by radiopharmaceuticals based on Auger electrons emitters, and especially emitters of α particles.

The advantage of radiopharmaceuticals labelled with α and Auger electron emitters is the ability to deposit high energy on a small area of tissue, while double-stranded DNA chain breakage is observed. Due to the short range of the α and Auger electron particles, the therapeutic effect is limited to diseased cells and healthy tissues are not destroyed. Currently, the following radionuclides are considered – emitters of α radiation: $^{213}$Bi, $^{211}$At, $^{223}$Ra, $^{225}$Ac and $^{149}$Tb. Among the Auger electron emitters, most reports are devoted to radiopharmaceuticals based on $^{125}$I, $^{111}$In and $^{67}$Ga.

In the first part of the lecture, new therapeutic radiopharmaceuticals based on α and Auger electron emitters will be presented. Particular attention will be paid to various concepts of binding radionuclides with biologically active molecules, the properties of the obtained radiopharmaceuticals and the first results of their use in clinical trials.

In the second part of the lecture, works related to the preparation of radiopharmaceuticals labelled with α and Auger electron emitters, which are currently carried out and are planned at the Institute of Nuclear Chemistry and Technology in Warsaw, will be discussed. The following topics will be presented: the concept of binding $^{211}$At with a biomolecule through the use of a metal bridge, nanozeolites and barium ferrite nanoparticles labelled with $^{223}$Ra and studies on the possibility of application radiopharmaceuticals based on $^{195m}$Pt and $^{103}$Pd/$^{103m}$Rh Auger emitters.

# ORAL ABSTRACTS

## O-1 Isotopic Composition of Environmental Water Samples from Sava River Basin in Croatia and Serbia

**Nataša Todorović**[1], Zoran Kovač[2], Jadranka Barešić[2], Jovana Nikolov[1], Christoph Henrich[3], Oliver Kracht[4]

[1]University of Novi Sad, Faculty of Sciences, Department of Physics, Novi Sad, SERBIA
[2]University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering, Laboratory for Spectroscopy, Zagreb, CROATIA
[3]International Atomic Energy Agency, Department of Technical Cooperation, Vienna, AUSTRIA
[4]International Atomic Energy Agency, Department of Nuclear Sciences and Applications, Vienna, AUSTRIA

The Sava River is the largest (by discharge) tributary of the Danube and it has been identified as the main recharge source for the alluvial aquifers in its basin, especially in the upper part of the flow, in Slovenia and Croatia. However, only a limited amount of research has been conducted downstream of the Zagreb area (Croatia) which could potentially ascertain the magnitude of influence of the Sava River on the groundwater resources. Characterization of the aquifer may be conducted by different tracers which must be visible or measurable, and conservative. Tritium chemically behaves like other hydrogen isotopes ($^1$H and $^2$H) and enters the water cycle as a part of $H_2O$, and, as such, represents an ideal tracer, together with stable water isotopes. In the framework of IAEA Regional Technical Cooperation Project RER 7013 "Evaluating Groundwater Resources and Groundwater – Surface Water Interactions in the Context of Adapting to Climate Change", samples of precipitation, groundwater, and surface water from 6 locations in Serbia and Croatia have been investigated for their tritium content and stable isotopes of water ($\delta^2$H and $\delta^{18}$O). Tritium activity was measured at the Ruđer Bošković Institute Laboratory for Low-Level Radioactivity, by the liquid scintillation counter Quantulus 1220. All samples were electrolytically enriched before the measurements. Stable isotopes of water ($\delta^2$H and $\delta^{18}$O) were determined by laser absorption spectroscopy at the Laboratory for Spectroscopy, Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb. This research aims to define groundwater-surface water interactions in the different parts of the Sava River basin, but also identify where Sava River has a greater influence on groundwater resources. Evaluation of the isotopic results will determine the relationship between the Sava River, precipitation, and alluvial aquifers, while historical hydrological and meteorological data will additionally be used to test the influence of climate change on groundwater resources. All this will help to identify and implement measures for sustainable groundwater resources management in the Sava River basin.

**Keywords:** Tritium, Stable isotopes, Hydrogeology, Radioecology

## O-2 Investigation of the Effect of Fuel Type and Reflector Material on Neutronic Performance in Molten Salt Reactors

Ali Tiftikçi[1], Hüseyin Şahiner[1], **Meryem Seferinoğlu**[1], Hüseyin Ayhan[2]
[1]Sinop University, Faculty of Engineering and Architecture, Nuclear Engineering Department, Sinop-TÜRKİYE
[2]FİGES Engineering, R&D Center, Nuclear Technology Department, Ankara-TÜRKİYE

Requirements for safe, sustainable, economic, and proliferation resistance in nuclear energy forced the nuclear technologies to look for more options. Molten Salt Reactors (MSRs) are one of the six reactor types selected for next-generation (GEN-IV) nuclear reactors. MSRs use molten fuel with high temperature and low pressure. This solves the fuel melting and explosion problems in traditional reactors. High volumetric heat capacity, high thermal efficiency, high burnup rate, low radiotoxicity, low waste amount, low investment cost, inherent passive safety, sustainable fuel as thorium and/or minor actinides, and negative void coefficient are some other advantages of MSRs. More safety features of MSRs draw attention to molten salt utilized reactors. Issues such as material damage, chemical behavior, and defining licensing criteria are not well-known. As uranium reserves are limited, MSRs should be put into practice sooner. This study was conducted to investigate the effect of geometric configuration, reflector type, and fuel composition on the neutronic performance of the MSR core. Square cylinder geometry was chosen to minimize the neutron leakage. Two different molar composition (Fuel 1: 77.5% LiF-20% $ThF_4$-2.5% $UF_4$ and Fuel 2: 77.5% LiF-17.5% $ThF_4$-5% $UF_4$) and selected reflector materials (Hastelloy-N, $Zr_3Si_2$, $B_4C$, MgO, ZrC, TiC, Be, BeO and C) were used in neutronic calculations for fuel and reflector, respectively. SCALE 6.2 and SERPENT 1.1.7 Monte Carlo codes were employed to simulate neutron transport for the cylindrical core with stagnant fuel. The results showed that the reactor becomes critical when D=H=2.5 m (Fuel 1) and D=H=0.76 cm (Fuel 2) with a 10 cm Hastelloy reflector. Although SCALE and SERPENT results were found to be quite compatible in the criticality calculations for Fuel 1, SERPENT results were found to be approximately 2% higher for Fuel 2. This is thought to be due to the differences between the ENDF and JEFF libraries for the cross-section of the U-233 isotope. When reflector materials are compared, Be and BeO are the superior alternative for enhancing keff, while B4C is the best choice in terms of reducing the leakage rate. Thus, it was concluded that using a double-layer reflector (BeO+$B_4C$ or Hastelloy+$B_4C$) would be more effective.

**Keywords:** MSR, Monte Carlo, Neutronics, Thorium fuel

## O-3 Determination of the Radiological Consequences of a LBLOCA with SBO Severe Accident By Means of the ASTEC and JRODOS Codes at a Generic Akkuyu VVER-1000 Plant Unit

**Ahmet Kağan Mercan**[1], Fabrizio Gabrielli[1], Victor Hugo Sanchez-Espinoza[1], Wolfgang Raskob[1]
[1]Karlsruher Institute for Technology (KIT), GERMANY

The estimation of the Fission Product (FP) in a hypothetical Severe Accident (SA) in a NPP is a key information to be provided to the emergency teams in order to support the decision making in such events. After the Fukushima accident in particular, such evaluations become more and more important in the safety assessment of a NPP. In order to sustain fast and reliable consequence analysis, integral codes are employed to analyze the radiological consequences of SA scenarios in worldwide. Particularly, ASTEC, developed by IRSN, is used to simulate the full SA scenarios from the initiation up to the FP release to the environment. JRODOS supports use of radiological monitoring information, operational weather forecast data and hydro-meteorological scenarios to perform the modelling of the transport of the radionuclides, deposition as well as the estimation of the potential and long term doses. Having this in mind, a platform of reference codes for the FP evaluation and the analysis of the dispersion during a SA has been assessed. For such first-of-its-kind platform, the accident of LBLOCA on the hot leg along with SBO has been employed for the ST evaluation. Such results are then employed by JRODOS for the calculation of the FP dispersion. The ASTEC results of the main events characterizing the accident progression, the Source Term (ST), and the in- and ex-vessel hydrogen generation are calculated until the rupture of the cavity. Acquired ST inventory of 141 isotopes is provided to the JRODOS in order to determine radiological impact of such release to the environment. To sum up, reactor pressure vessel failure and cavity rupture are observed after 8 hours. Total hydrogen generation during in-vessel phase reaches 604 kg and contribution of hydrogen generation by ex-vessel phenomena is about 866 kg in which makes the total generation almost 1500 kg cumulatively. The activity that leaks to the environment is approximately 8PBq at the end of the transient. Dispersion analysis by JRODOS shows that the total contamination affects almost 200 million people and reaches 11.5 GBq per area by aerosols which indicates 191.44 Sv potential effective dose as maximum.

**Keywords:** VVER, ASTEC, JRODOS, Akkuyu, Source term

## O-4 The Radiolabeling of Fingolimod With [$^{99m}$Tc] and Evaluation of Biological Effects with In Vitro Methods

**Emre Uygur**[1], Yasemin Parlak[1], Ayfer Yurt Kılçar[2], Kadriye Büşra Karatay[2], Fikriye Gül Gümüşer[1], Fazilet Zümrüt Biber Müftüler[2]
[1]Manisa Celal Bayar University, Manisa-TÜRKİYE
[2]Ege University, Izmir-TÜRKİYE

Fingolimod (FTY-720) is the first oral drug approved by the US Food and Drug Administration for the treatment of a relapsing and remitting form of multiple sclerosis disease. FTY-720 acts on central nervous system cells that cross the blood-brain barrier and express Sphingosine-1-phosphate receptors (S1PRs), including neurons. FTY-720 protects against neural damage caused by mitochondrial dysfunction, cytotoxicity, and ischemia-reperfusion injury through modulation of S1PR1. It has also been reported to be effective against neurodegeneration in Parkinson's disease (PD). Biomarkers for neurological imaging in the diagnosis of PD are performed using Single Photon Emission Computer Tomography (SPECT), Positron Emission Tomography (PET), Magnetic Resonance Imaging, and Transcranial Sonography methods. For nuclear imaging, there are a few pieces of research about radiolabeling S1p receptors such as fluorine-18 and carbon-11 for PET, and iodine-123 for SPECT. However, it was not found any study about technetium-99m [$^{99m}$Tc] radiolabeled FTY-720 ([$^{99m}$Tc]Tc-FTY-720) in the literature. [$^{99m}$Tc] is an easy, convenient, economical radionuclide used in the development of diagnostic kits in nuclear medicine, because of its ideal gamma energy (140 KeV) and physical half-life ($t_{1/2}$ = 6 hours). The study is aimed to radiolabel FTY-720 with [$^{99m}$Tc], to evaluate biological effects with in vitro methods. FTY-720 was radiolabeled with [$^{99m}$Tc]. Radiolabeling and stability studies of [$^{99m}$Tc]Tc-FTY-720 were performed by using the thin-layer radio chromatography (TLRC) method using the cyclone storage phosphor system (Perkin Elmer). For the in vitro study, an experimental Parkinson's group was established via rotenone-induced neurotoxicity in dopaminergic human neuroblastoma (SH-SY5Y) and rat pheochromocytoma (PC-12) cell lines. The incorporation of [$^{99m}$Tc]Tc-FTY-720 and cytotoxicity of inactive FTY-720 were investigated in the experimental and control groups. Experimental results show that [$^{99m}$Tc]Tc-FTY-720 (% 98.04 ± 1.60, n=3) can be radiolabeled with [$^{99m}$Tc]. The stability of [$^{99m}$Tc]Tc-FTY-720 is over %95 during the four hours. It was observed that the cytotoxicity of FTY-720 increased with increasing concentrations and [$^{99m}$Tc]Tc-FTY-720 showed uptake in SH-SY5Y and PC-12 cell lines. As a result, it was concluded that the potential use of [$^{99m}$Tc]Tc-FTY-720 in the diagnosis of PD and MS must be supported by more extensive in vitro and in vivo experimental animal model studies.

**Keywords:** Fingolimod, Parkinson's disease, Multiple sclerosis

## O-5 Proficiency Tests on the Determination of Radioactivity in Food and Environmental Samples Organized in Poland

**Leon Fuks**[1], Pawel Kalbarczyk[1], Ewa Topyla[1]
[1] Institute of Nuclear Chemistry and Technology, Dorodna 16, 03-195 Warsaw-POLAND

Involvement in the interlaboratory comparisons (ILC) and proficiency tests (PT) is a valuable tool to assess laboratory competence. It allows also improving the quality of laboratory routine work and comparing its results with those of other laboratories. It can be also used to verify the reliability of the data produced by a laboratory and provide confidence in measurement results to the users of laboratory services. In Poland, the PTs on the determination of selected man-made radionuclides in food and environmental samples have been organized by the National Atomic Energy Agency (NAEA), Poland, since 2004. The Institute of Nuclear Chemistry and Technology has been responsible for conducting the PTs in accordance with ISO standards [1,2]. The activity of the following radionuclides: $^{3}$H, $^{137}$Cs, $^{90}$Sr, $^{239}$Pu, $^{241}$Am, and $^{226}$Ra were determined by several Polish laboratories forming the country's radiation monitoring network. The test materials: water, milk (liquid or powder), wheat flour, different dry vegetable powders, and soil, were prepared by spiking blank materials with the standard solution of the radionuclide of interest. The activity concentrations were calculated, and associated uncertainties were evaluated before sending the test materials to the laboratories. The results provided by the participants were converted into z and zeta scores [3], as well as treated using the International Atomic Energy Agency (IAEA) criteria [4], the purpose of which is to provide a basis for instigating remedial action where necessary. The observed trends of these analyses are presented. The proficiency tests have been initiated and funded by National Atomic Energy Agency (Poland) in the framework of annual contracts with the Institute of Nuclear Chemistry and Technology.

[1] EN ISO/IEC 17043:2010 Conformity assessment. General requirements for proficiency testing. Geneva, February 2010.

[2]. ISO 13528:2005 Statistical methods for use in proficiency testing by interlaboratory comparisons. Geneva 2005.

[3]. z-Scores and other scores in chemical proficiency testing - their meanings, and some common misconceptions. Analytical Methods, 8(28), 2016, 5553-5555. doi:10.1039/c6ay90078j

[4]. A. Shakhashiro, A. Trinkl, U. Sansone, The IAEA's ‘ALMERA Network’ proficiency test on the determination of gamma-emitting radionuclides: A test of results comparability, Appl. Rad. Isotopes, 66(11), 2008, doi:10.1016/j.apradiso.2007.10.021

**Keywords:** Interlaboratory comparisons, Proficiency tests, Radionuclide determination, Environmental samples, Food, Statistical analysis

## O-6 Removal of Radionuclides from the Radioactively Contaminated Water by Sorption and Sorbent-Assisted Ultrafiltration

**Leon Fuks**[1], Agnieszka Miskiewicz[1], Grazyna Zakrzewska-Koltuniewicz[1], Agata Oszczak-Nowinska[2], Andrzej Swiatkowski[2], Joanna Fronczyk[3]
[1]Institute of Nuclear Chemistry and Technology, Dorodna Str. 16, 03-195 Warszawa-POLAND
[2]Military University of Technology, Gen. S. Kaliski Str. 2, 00-908 Warszawa-POLAND
[3]Warsaw University of Life Sciences - Sggw, Nowoursynowska Str. 166, 02-787 Warsaw-POLAND

Contamination of water with radioactive compounds results mainly from nuclear detonations or false management of nuclear materials and waste. In addition, these pollutants can enter the water because of mining materials that comprise radioactive impurities, e.g., thorium or uranium. Until today, many physical and chemical processes for decontamination of water have been assessed. Due to its simplicity, effectiveness, and low cost, sorption is one of the most applied technologies, especially when natural materials are used. Sorption is a process that profits from the attachment of the water contaminating substances to the water-immiscible sorbent. However, in industrial-scale processes, it may be difficult to separate the treated water from the contaminated sorbent. Therefore, this method is used not only as a stand-alone process but also in combination with the membrane filtration processes. The latter is the physical separation method used to separate molecules of different sizes and characteristics. So, if small radioactive ions present in water have been converted into big-sized sorbent-metal complexes, such hybrid technology allows for the purification of water (small molecules) from the contaminant. When ultrafiltration is used, we call this method Sorbent Assisted Ultrafiltration (SAUF). In the presented studies, batch sorption of $^{137}$Cs(I), $^{85}$Sr(II), $^{60}$Co(II), and $^{241}$Am(III) on the Norit ROW 08 Supra activated charcoal (popular sorbent in the commercial treatment of drinking water) was studied. Values of the Decontamination Factor (DF, i.e., ratio of the specific activity before and after the decontamination process) have been determined and analyzed. Presented in the paper results show that, in most cases, sorption on the Norit ROW 08 SUPRA commercial charcoal may be used for the effective removal of radionuclides from aqueous solutions. In more detail, the purification quality does not depend significantly on the acidity of the solution, and the required contact time with the sorbent should be about 2 hours. It has been also shown, that the Sorbent Assisted Ultrafiltration procedure used for removal of the radioactive metals from aqueous solutions assures obtaining of high purity water, both radiochemically and chemically.

**Keywords:** Decontamination, Water purification, Radionuclides, Sorption, Sorbent-assisted Ultrafiltration

## O-7 Short-Term Nuclear Sciences Curriculum Developed for Science Teachers Working in Science and Art Centers

**Emre Uygur**[1], Fazilet Zümrüt Biber Müftüler[2], Hüseyin Eş[3], Mehmet Başaran[4]
[1]Manisa Celal Bayar University, Manisa-TÜRKİYE
[2]Ege University, Izmir-TÜRKİYE
[3]Sinop University, Sinop-TÜRKİYE
[4]Gaziantep University, Gaziantep-TÜRKİYE

The subject of "nuclear," frequently on the agenda due to the nuclear power plants under construction in Sinop and Mersin in Turkey, is an essential socio-scientific issue. However, due to unscientific discussions in the press and internet media, negative judgments may occur in some parts of society, including teachers. In the research conducted on the teachers, it is seen that they have negative opinions about establishing a nuclear power plant in Turkey. When the reason for this situation is examined, they do not have prior knowledge about nuclear energy and have different attitudes according to the field, political opinions, and socio-economic status. The study aims to introduce the short-term (5 days) curriculum developed within the scope of the project (project no:121B387) named "Nuclear Sciences School for Science Teachers Working in Science and Art Centers (BILSEM)" supported by TÜBİTAK 4005 Innovative Educational Practices and carried out between 23-27 August 2021 in Manisa Celal Bayar University. The curriculum, which is based on applied activities, has been developed for science teachers working in BILSEM depending on the thematic approach. Day 1 Theme: Nuclear as a Science Day 2 Theme: Application Areas of Nuclear Sciences Day 3 Theme: Digital Nuclear Day 4 Theme: Nuclear Based Socio-scientific issues and pedagogy Day 5 Theme: Measurement and evaluation activities Seventeen activities were carried out during the program with 27 academic experts in nuclear science. The program developed included applications not only in the field of energy but also in the fields of medicine, industry, and archaeology, in an integrated manner with today's technology of nuclear sciences, participant-centered, arousing interest and curiosity about the subject, knowledge, and skills of the latest technological methods and techniques on the subject, accompanied by innovative approaches. It was also created in an integrated manner with digital learning tools. At the end of the project, it was targeted that those science teachers would understand the scientific facts about nuclear sciences with the education they had received, develop, and use their decision-making skills by considering the multidimensional nature of the subject.

**Keywords:** Nuclear science, Nuclear energy, Science education

## O-8 Comparison of Peptide Radiolabelling with Gallium-68: Nota vs. DO3A

**Aynil Çetin** [1], Stephen J. Archibald[2], Juozas Domarkas[2], David Roberts[2]
[1]Turkish Energy Nuclear and Mineral Research Agency Proton Accelerator Facility, Saray Mah. Atom Cad. No: 27 Kahramankazan/Ankara-TÜRKİYE
[2]Department of Chemistry, Department of Biomedical Sciences And Pet Research Centre, University of Hull Cottingham Road, Hull, UK

Positron emission tomography (PET) is a non-invasive nuclear medicine technique applying positron-emitting radionuclides to visualize and quantify biological targets or biochemical processes at the cellular or molecular level. The ability to image receptor expression in vivo could be used to better understand the physiological role of GPCRs and assist in the development of targeted therapies for cancer. In this work, the radiometal gallium-68 is used to radiolabel two peptide derivatives (PepDO3A and PepNOTA) to compare the labelling efficiency of the chelators DO3A and NOTA respectively. The principal advantage of radiometal, including gallium-68, labelling over fluorine-18 labelling, is that metals can be quantitatively coordinated in conditions compatible with biomolecules (aqueous media, near-neutral pH, room temperature) at a very low precursor concentration, enabling one-step, kit-based radiolabelling protocol. This is dependent on the chelator and DOTA conjugated peptides (forming the DO3A chelator) tend to require more forcing conditions,including longer reaction times and elevated temperature. The radiolabelling was carried out in 0.5 M sodium acetate buffer pH 4-4.5 and was optimised for the amount of precursor,time and temperature of reaction. Under the optimised conditions, tracer [$^{68}$Ga]GaPepNOTA was prepared as a purified tracer starting from 250 MBq in a 50% decay corrected yield in an hour from elution of generator,similarly, tracer [$^{68}$Ga]GaPepDO3A was prepared as a purified tracer in 47 ± 2% (n =2) decay corrected yield in just over an hour from elution of generator (lower activity experiments were used for selection of conditions in both cases). The main difference in the two sets of optimised conditions are the temperatures used for the reactions (both optimised reactions used 20 microgram of precursor and 5 min incubation time with labelling at room temperature for PepNOTA and 90°C for PepDO3A). The use of PepNOTA conjugate vs the PepDO3A conjugate did not result in shorter preparation times for corresponding tracers but does offer the significant advantage of room temperature radiolabelling. Thermal instability of PepDO3A was not a major factor and so the yield of [$^{68}$Ga]GaPepDO3A was similar to [$^{68}$Ga]GaPepNOTA. However, PepDO3A offers a chelator for a therapeutic isotope if the radiopharmaceutical is to be considered in theranostic applications.

**Keywords:** Positron emission tomography, PET, GPCR, G protein-coupled receptor, Gallium-68, DO3A, NOTA, Radiolabeling, Theranostic

## O-9 Assessment of the ASTEC Model of a Generic BWR-4 Mark-1 Peach Bottom Unit-2 NPP and Analysis of the ST-SBO Severe Accident Scenario

**Onur Murat**[1], Victor Hugo Sanchez Espinoza[1], Fabrizio Gabrielli[1], Robert Stieglitz[1]
[1]Karlsruhe Institute of Technology, GERMANY

Fukushima Daiichi severe accidents were the last major nuclear events which emphasizes the safety status of the nuclear power plants. Impact of the accidents made a necessity to reevaluate safety status of the current operating power plants to enhance the understanding of the accidents and making development and improvements of severe accident management guidelines. In order to assess the safety integrity of the power plants, severe accident codes such as ASTEC were employed to simulate the severe accident transients from initiating event to core degradation and release of radioactive materials. ASTEC is the European reference severe accident integral code developed by the IRSN and mainly focused on PWR type reactors. Thanks to collaboration between KIT and IRSN and new implemented BWR related models, ASTEC V2.2 in revision 6330 development version was employed for the accident simulation. Selection of the plant based on the previous U.S.NRC severe accident risk assessment studies which considers the Peach Bottom Unit-2 BWR4 Mark-1 power plant. Including with containment building reactor pressure vessel and water cycle model introduced with appropriate models. Most anticipated severe accident scenario short term station-blackout was selected and simulation up to cavity basemat failure completed. Early degradation was recorded and lower head vessel failure occurred around 2.5 hours after accident initiation. Tracking of the fission product through core to the containment building and finally in environment performed. Based on the retention potential of the water intake of the suppression pool, driven fission products are trapped in the wetwell region and insignificant amount of release to the environment recorded. Basemat rupture and simulation completed at around 11.5 hours after accident initiation.

**Keywords:** Severe accident, ASTEC, BWR, SBO

## O-10 Using Pet Wastes as an Adsorbent for Ce and Sr Removal from Aqueous Solution

**Senol Sert**[1], Yunus Tascı[1]
[1]Insititute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

In this study main objective is aimed to evaluate PET waste -one of the most important types of plastics which have become a major environmental problem- by using it in a new area and to evaluate it economically. For this purpose, the use of PET waste as an adsorbent in the removal of some radiotoxic elements that may be present in aqueous solutions during nuclear accidents or the processing of nuclear wastes has been investigated. Adsorption studies were carried out by using simple PET and then by modifying with Phenol. The modified PET adsorbent (Phenol-PET) was characterized using FT-IR, TGA and SEM. Metal uptake experiments were carried out by batch method and the effecting initial pH value, initial concentration, shaking time, and temperature factors were investigated. In sorption experiments using PET; for Ce (III) the dilaverum uptake occurs at pH 5 and 6 while for Sr (III) is between 7 and 9. In the experiments carried out using Phenol-PET, the uptake is highest for Sr (II) at pH 9. In the initial concentration studies, it was observed that saturation of 20 mg/L for Ce (III) and 25 mg/L for Sr (II) was reached with PET adsorbent. Experiments of Sr (II) sorption with Phenol-PET adsorbent showed that saturation was achieved in the range of 50-75 mg/L. In the experiments using PET, the time to reach equilibrium was 20 minutes for Ce (III) and 15 minutes for Sr (II) while the highest metal uptake was observed in the first 3 minutes of Sr (II) uptake with Phenol-PET. No significant effect was observed during the studies in which the effect of temperature was examined. According to the isotherm data of Ce (III) and Sr (III) adsorption using PET and Phenol-PET, all of them were found to be compatible with the Langmuir isotherm and according to the D-R data, all processes could be defined as ion exchange.

**Keywords:** Adsorption, Strontium, Cerium, Polyethylene terephthalate, Plastic waste

## O-11 TENMAK-NUKEN, Proton Accelerator Facility (PAF) Set-Up of an Irradiation and Measurement System for Non-Destructive Ion Beam Analysis Techniques (PIXE, PIGE, RBS, ERDA, NRA) and R&D Irradiation Services

**Dilaver Porsuk**[1], Görkem Türemen[1], Emin Yeltepe[1], Serdar Bulut[1]
[1]Turkish Energy, Nuclear and Mineral Research Agency (TENMAK-NÜKEN), Ankara-TÜRKİYE

In the R&D room of the TENMAK NUKEN PAF provides irradiation service in-vacuum and in-air with well-known proton beam characteristics within the limitations of the cyclotron and the irradiation setup (currently between sub-nanoampere currents up to 100 µA and energies between 2.5 MeV and 30 MeV). In irradiation system, a wide variety of research can be performed at low currents, including radiation damage tests and non-destructive material analysis such as PIXE, PIGE, ERDA and RBS in-vacum.

**Keywords:** PIXE, PIGE, RBS, ERDA, Irradiation service

## O-12 Investigation of Nanocomposites Efficiency on the Separation and Purification Processes of Thorium and Rare Earth Elements

**Bekir Özkan**[1], Yüksel Altaş[1]
[1]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

One of the important deposits containing thorium in the world is located in Eskişehir - Beylikahır (Beylikova) region of Turkey. Although the thorium grade (average 0.21%) in the ore is low, considering the size of the reserve (380 thousand tons $ThO_2$) and the importance and amount of rare earth elements (REE) (approximately 4.5 million tons) its evaluation is very important for our country's economy. The aim of this study is to investigate and evaluate the separation performance of $SiO_2$, $TiO_2$ and $ZrO_2$ based nanocomposites for thorium and REEs. Eskisehir-Beylikova ore was used as thorium and rare earth element source. In the first step, the ore was heated up to 400°C for 2h to breakdown the $-CO_3$ structure into $CO_2$ and $O_2$. Roasting process increased leaching yield for more than 25% with lower acid concentrations. The ore was leached with acids and the parameters (contact time, liquid/solid ratio, temperature, concentration of acid solution) were optimized. Results indicate that acid solutions with one molar concentration was enough to achieve 90% leaching yield for REEs. In order eliminate impurities (Cr, V, Zr) from the matrix, thorium and rare earth elements were precipitated as oxalates from leach solution. This precipitate was dissolved in a proper process and used as a stock solution for adsorption studies. $TiO_2$, $ZrO_2$ and $SiO_2$ nano powders were synthesized in hydrothermal reactor. The synthesized powders were then washed with ethanol and dried for 24h. Nanocomposite materials were prepared by combining polyacrylonitrile and nano metal oxide powders. Polyacrylonitrile used as a binder/support material for metal oxides. In adsorption studies the effect of contact time, adsorbent/solution volume ratio, pH of the solution and the temperature were investigated. Samples were analyzed by using ICP-OES and adsorption yield, adsorption capacity and separation factor were calculated.

**Keywords:** Rare earth elements, Nano composite, Separation, Adsorption

## O-13 Separation of Neodymium and Dysprosium from Aqueous Solution Using Tin Phosphate

**Murat Şentürk**[1], Süleyman İnan[2]
[1]Silkar Madencilik San. ve Tic. A.Ş. TÜRKİYE
[2]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

Neodymium and dysprosium are found in computers, appliances, etc. It is the main component of the magnets used. Since the supply of rare earth elements is limited, obtaining these elements from secondary sources has become very important. In this study, tin phosphate compound was prepared and characterized. In order to determine the sorption conditions of Nd(III) and Dy(III) in single element solutions, the effects of initial pH, contact time and initial metal concentration parameters were investigated. Maximum uptake capacity for Nd(III) and Dy(III) was obtained at pH 4 and pH 3, respectively. The separation conditions of Nd(III) and Dy(III) from ternary solutions containing Nd(III), Dy(III) and Co(II) ions were investigated as a function of initial pH and initial metal concentration. In a solution with an initial pH of 4 and containing an equimolar concentration of 5 mM Nd(III), Dy(III) and Co(II), distribution coefficients (Kd) for Nd(III), Dy(III) and Co(II) were found as 14601.58, 7788.48 and 640.34 mL/g, respectively. In solutions with an initial metal concentration of 10 mM, the Kd values obtained for Dy(III) in the pH range of 2-6 are higher than Nd(III). The Kd values obtained for Nd(III), Dy(III) and Co(II) at 10 mM initial metal concentration and pH 6, are 4100.51, 4234.53 and 234.67 mL/g, respectively. Stripping efficiencies for Nd(III) and Dy(III) in a single step with 1.0 M $HNO_3$ were calculated as 52.27% and 56.08%, respectively.

This work was supported by Ege University Scientific Research Projects Coordination Unit. Project Number: FGA-2021-22389.

**Keywords:** Neodymium, Dysprosium, Rare earth elements, Tin(IV) phsophate, Sorption

## O-14 Radiolabeled Lapatinib (LPT) and its PLGA Formulation as Potential Radiotracers

Sevki Goksun Gokulu[1], Ayfer Yurt Kilcar[2], Ahmet Bilgi[3], **Kadriye Busra Karatay**[2], Levent Akman[4], Cansu Kayas[5], Nuri Yildirim[6], Fazilet Zumrut Biber Muftuler[2], Mustafa Cosan Terek[4]
[1]Department of Gynaecologic Oncology, Medical Faculty Hospital, Mersin University, Mersin, TÜRKİYE
[2]Department of Nuclear Applications, Institute of Nuclear Sciences, Ege University 35100 Bornova, Izmir, TÜRKİYE
[3]Department of Obstetrics and Gynaecology, Faculty of Medicine, Selçuk University, Konya, TÜRKİYE
[4]Department of Obstetrics and Gynaecology, Faculty of Medicine, Ege University, Izmir, TÜRKİYE
[5]Institute of Health Sciences, Dokuz Eylul University, Balcova, Izmir, 35330, TÜRKİYE
[6]Faculty of Medicine, Ege University, Izmir, 35100, TÜRKİYE

Nanocarriers have found their place in modern medicine. Nowadays some researchers are interested in nanocarriersand their radioactive compounds with specific administrations for diagnostic theranostic applications. In the literature, there are many approaches can be used for the preparation of drug-loaded poly(D,L-lactic-co-glycolic acid) (PLGA) nanoparticles, because of its favorable stability, solubility, excellent biocompatibility, biodegradability. Technetium-99m ($^{99m}$Tc) is an easy, convenient, and economical radionuclide used in the development of diagnostic agents in Nuclear Medicine due to its suitable energy and half-life (140 KeV, $t_{1/2}$ = 6 hours). The current study aims to investigate the radiolabeling potentials of Lapatinib (LPT) and its PLGA formulation (LPT-PLGA) with $^{99m}$Tc as a probable tyrosine kinase inhibitor radiotracer. It is known that LPT is a dual tyrosine kinase inhibitor which increases cell apoptosis by inhibition of epidermal growth factor receptor and human epidermal growth factor receptor 2. First of all, the characterization of LPT and LPT-PLGA was determined using Scanning Electron Microscopy (SEM) and Dynamic light scattering (DLS), and also Fourier Transform Infrared Spectroscopy (FTIR) spectra of LPT and LPT-PLGA were obtained. Lipophilicity and stability studies of $^{99m}$Tc-LPT-PLGA were assessed and compared with $^{99m}$Tc radiolabeled LPT. According to SEM results and DLS results, LPT-PLGA nanoparticles have spherical morphology and the size distribution of LPT-PLGA was measured as 225.60 nm (%) (PdI: 0.40) by DLS method. On the other hand, radiolabeling yields of $^{99m}$Tc labeled compounds were over 95 %. $^{99m}$Tc-LPT and $^{99m}$Tc-LPT-PLGA were stabil over 90 % for 4 hours. It is thought that the radiolabeled LPT and LPT-PLGA will contribute to the development of new image agents in Nuclear Medicine. Additionaly, further in vitro investigations using breast, cervical and ovarian cancer types are needed to examine their imaging potentials.

**Keywords:** Lapatinib (LPT), Tyrosine kinase inhibitor, poly(D,L-lactic-co-glycolic acid) (PLGA) formulation, Technetium-99m ($^{99m}$Tc), Radiotracer

## O-15 Radiolabeled Antiepileptic Drug: [$^{99m}$Tc]Tc-Zonisamide

**Emine Dervis**[1], Kadriye Busra Karatay[1], Kubra Durkan[1], Ayfer Yurt Kilcar [1]
[1]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

Zonisamide (ZNS), which is in the second-generation antiepileptic drug group, is a broad-spectrum drug classified as sulfonamide chemically and completely different from the mechanism of other antiepileptic drugs. 1,2-benzisoxazole-3-methanesulfonamide, ZNS with a molecular weight of 212,23g/mol has been approved for clinical use. It is used in the treatment process of symptoms of epilepsy and Parkinson's diseases. The safety, efficacy, and control of ZNS has been widely proven in clinical studies, it has been reported as a drug with low drug-drug interaction potential compared to other antiepileptics and has been recommended as a treatment option in the control of seizures. In present study; it's aimed to radiolabel ZNS with Technetium-99m ($^{99m}$Tc), which is one of the most frequently used radionuclides in Nuclear Medicine, and to determine its in vitro potential. $^{99m}$Tc is an easy, convenient, economical radionuclide used in nuclear medicine, due to its ideal gamma energy (140 KeV) and physical half-life ($t_{1/2}$ = 6 hours). It is anticipated that radiolabeled ZNS ([$^{99m}$Tc]Tc-ZNS) may have promising potential use as a neuroimaging agent.. With this purpose; ZNS, an antiepileptic drug, is radiolabeled with an important imaging radionuclide, [$^{99m}$Tc]$TcO_2$. It has been shown that ZNS has high efficiency radiolabeling potential with the chromatographic quality control methods. In addition, in vitro and radiostability of [$^{99m}$Tc]Tc-ZNS has been determined. Within the scope of in vitro cell culture studies; the effect of ZNS on cell viability of SH-SY5Y cells was determined and bioaffinities of radiolabeled drug [$^{99m}$Tc]Tc-ZNS on cells was investigated. As a result of the quality control studies, it was determined that the radiolabeling efficiency was show that % 98,03 ±1,24 (n=6). The stability of [$^{99m}$Tc]Tc-ZNS was over %95 during the four hours. While in vitro stability for [$^{99m}$Tc]Tc-ZNS appears to be maintained for 4 hours, possible in in vivo applications after radiolabeling would have to be performed within the first 30 minutes. For [$^{99m}$Tc]Tc-ZNS, cell uptake was significantly higher on SH-SY5Y cells compared to pertechnetate. Further studies will be planned to investigate the potential of the radiolabeled antiepileptic drug at the imaging of neurological processes.

**Keywords:** Zonisamide (ZNS), Antiepileptic drugs, Epilepsy, Technetium-99m [$^{99m}$Tc]$TcO_2$. Neuroimaging

## O-16 Risk Assessment of Marine Radioecology and, Trace Elements via Antioxidants

**Nurdan Akakçe**[1], Aysun Uğur Görgün[1], İnci Tüney Kızılkaya[2], Nevra Öztürk Atay[3]
[1]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE
[2]Ege University Faculty of Science Hydrobiology, Izmir-TÜRKİYE
[3]Ege University Central Research Test and Analysis Laboratory Application and Research Center, Izmir-TÜRKİYE

The present study is related to the determination of radionuclides and trace elements by using macroalgae species in marine ecology and assessment for the antioxidant defense system. The study is focused on radioactive pollution both stress responses. Nuclear techniques were used in samples for calculation of $^{210}$Po, $^{238}$U, $^{232}$Th, $^{40}$K concentrations. Trace elements of Al, Fe, Mn, Cr, As, Zn, Pb levels were determined by the Energy Dispersive XRF device. SOD, APX, CAT, proline, and lipid peroxidation analysis in macroalgae are very important to understand the sensibility of radioactivity. Therefore, it has been foresight that information of the antioxidant defense system against the radionuclide and trace element stress effects. The antioxidants and their activation elements are very important for understanding and more explaining the defense and reflex of biological systems.

**Keywords:** Brown algae, Radiation, Heavy metal, Enzymes, Defence mechanism

## O-17 In Vitro Evaluation of Radiolabeled Methotrexate Loaded Magnetic Nanoparticle Delivery System

Sara Uzuğ[1], **Oğuz Çetin**[2], Burcu Aydin[2], Çiğdem İçhedef[2], Serap Teksöz[2]
[1]Ege University - Materials Science And Engineering, Izmir-TÜRKİYE
[2]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

In the search for more effective cancer targeting systems, radiolabeled nanoparticles are attracting intense scientific interest due to their great potential in nuclear medicine. Nanoscale materials have unique physical and chemical properties have led to the development of several types of nanoparticles for various applications. Magnetic iron oxide nanoparticles (MNP) are among the most attractive theranostics. In this study, methotrexate (MTX) loaded magnetic nanoparticles (MNP) were synthesized and radiolabeled with technetium-99m. It is aimed to examine the biological behavior of this drug delivery system in vitro. Magnetic nanoparticles were synthesized via the chemical co-precipitation method using ammonium hydroxide as a precipitating agent. For this purpose, iron magnetic nanoparticles ($Fe_3O_4$) were synthesized, coated with alanine (Ala) and loaded with a folic acid antagonist MTX. Structure characterization for the synthesized drug-loaded nanoparticle (MNP-ALA-MTX) and MNP-Ala was determined by Fourier transform infrared spectroscopy (FT-IR). Structural characterization of MNP-Ala and MNP-Ala-MTX were achieved by Zeta Potential Analysis, Dynamic Light Scattering (DLS), Vibrating Sample Magnetometer (VSM), and Scanning Electron Microscope (SEM) images. MTX loaded magnetic nanoparticle (MNP-Ala-MTX) was radiolabeled with technetium-99m with 89% efficiency. In our study, human cervical cancer cell line (HeLa) and human breast (MCF-7) cancer cell lines were used. The effect of radiolabeled nanoparticles on cells was determined. It was found that drug loaded MNP nanoparticles showed higher uptake in MCF7 cells than in HeLa cells.

**Keywords:** Methotrexate, Iron oxide, Magnetic nanoparticles, Technetium, Cell culture

## O-18 Synthesis, Radiolabeling and In Vitro Evaluation of Azathioprine Loaded Magnetic Solid Lipid Nanoparticles

**Burcu Güngör**[1], Gökce Türkkanı[1], Oğuz Cetin[1], Çiğdem İchedef[1], Serap Teksöz[1]
[1]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

In recent years, the uses of nanotechnology in medicine have an increasing potential as an effective nanocarrier system. These systems are composed of nanoparticles, developed with the aim of maximizing therapeutic activity and minimizing undesirable side effects. These systems are called smart drug delivery systems. They are prepared from synthetic polymers or natural macromolecules (protein, cellulose, lipid etc.). Nanoparticles, known as smart drug delivery systems, help to transport chemotherapeutic agents to malignant tissues and cells and have a very important place in complementary and alternative treatment solutions. In this study, it is aimed to design a smart drug delivery system for the diagnosis and treatment of cancer cells. Magnetic-solid lipid nanoparticles were synthesized as drug delivery system and azathioprine (AZA), which is used in the treatment of many diseases as a chemotherapeutic agent with its immunosuppressive effect, was loaded into this system. Magnetic solid lipid nanoparticles have been synthesized via hot homogenization technique. This newly created system was radiolabeled with technetium and the biological behavior of the system was investigated in vitro. Quality control studies of azathioprine loaded radiolabeled magnetic solid lipid nanoparticles ($^{99m}$Tc-AZA-SLMNP) were performed by Thin Layer Radiochromatography (TLRC). The radiolabeling yield was obtained as 90.3% for AZA-SLMNP. Drug loading into the SLMNP was performed with three different drug ratios and highest yield has been found as 86 % with 2.5 mg azathioprine ratio via High Performance Liquid Chromatography (HPLC). Structural characterization of synthesized magnetic solid lipid nanoparticles (SLMNP) was performed by Dynamic Light Scattering (DLS) method, Zeta Potential Analysis, Scanning Electron Microscopy (SEM) imaging. The biological behavior of $^{99m}$Tc and radiolabeled magnetic solid lipid nanoparticles loaded with azathioprine ($^{99m}$Tc-AZA-SLMNP) was investigated in vitro in HaCaT human skin normal keratinocyte cell lines and U87 brain cancer cell lines.

**Keywords:** Azathioprine, Magnetic solid lipid nanoparticles, Technetium, Radiolabeling, Cell culture

## O-19 Evaluation of the $^{222}Rn$ and $CO_2$ Anomalies Around a Quaternary Fault System: Pınarbaşı Segment of the Izmir Fault

**Mutlu İçhedef**[1], Caner Taşköprü[1], Emre Tabar[2], Fulsen Özen[3], Gözde Taç Duman [4]
[1]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE
[2]Sakarya University Faculty of Arts and Sciences Department of Physics, Sakarya-TÜRKİYE
[3]Ege University Faculty of Agriculture Department of Soil Science and Plant Nutrition. Izmir-TÜRKİYE
[4]Ege University Faculty of Sciences Department of Chemistry, Izmir-TÜRKİYE

The earthquake with a magnitude of 6.9 occurred in the north of Samos Island on October 30, 2020, and caused great damage to Izmir. The main shock quickly destroyed 17 buildings in Bayraklı and caused the death of 117 people. Bayraklı district, where the earthquake caused the most damage, is 70 km far from the earthquake epicenter, remind the possible effects of an earthquake that will occur in an active fault passing through Izmir city center. The most important fault with a length of 40 km is the Izmir fault (IF). Soil gas measurements can provide information about natural processes through gases released from the earth's crust in metropolises with excessive urbanization. For this reason, we have focused on defining the geochemical characteristic of a Quaternary Fault System by soil gas anomalies. The study area is selected as Pınarbaşı Segment of the Izmir Fault which is a virgin area in terms of its seismic activity due to heavy urbanization. Soil gas measurements were performed by RAD7 radon detector and multigas data logger. The obtained data were entered as data layers to create a map using GIS.

**Keywords:** $^{222}Rn$, $CO_2$, Anomaly, Quaternary fault system, Izmir fault

## O-20 Geochemical Characteristics of $^{222}Rn$ and $CO_2$ within the Izmir and Bornova Fault

**Meryem Moustakim**[1], Caner Taşköprü[1], Mutlu İçhedef[1]
[1]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

The earthquake with a magnitude of 6.9 occurred in the north of Samos Island on October 30, 2020, and caused great damage to Izmir. The main shock quickly destroyed 17 buildings in Bayraklı and caused the death of 117 people. Bayraklı district, where the earthquake caused the most damage, is 70 km far from the earthquake epicenter, remind the possible effects of an earthquake that will occur in an active fault passing through Izmir city center. The most important fault with a length of 40 km is the Izmir fault (IF). Because of very intense urbanization, the geochemical characteristics of Radon and Carbon dioxide in the study area are unknown. This study is aimed to discuss the spatial patterns of soil gas compositions and examined the association between the recent tectonic structure and degassing process. For this purpose, soil gas samples were systematically collected from the ca. 1–1.5 km spacing grid in the study area.

**Keywords:** Izmir fault, Bornova fault, $^{222}Rn$, $CO_2$

## O-21 Adsorption of Uranium Ions from Aqueous Solutions by Graphene-Based Zinc Oxide Nanocomposites

**Ikbal Gozde Kaptanoglu**[1], Sabriye Yusan[2]
[1]Ege University, Graduate School of Natural and Applied Sciences, Department of Materials Science and Engineering, Bornova, Izmir, TÜRKİYE
[2]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

With the increase in nuclear energy production, the risk of contamination of water with radioactive waste is a problem that cannot be ignored. Therefore, the removal of uranium (UV(VI)) ions from aqueous solutions is of great importance. Adsorption technologies have proven to be a promising method for the purification of water and the removal of pollutants, with ease of use and cost advantage. In this paper, adsorption potentials of U(VI) ions were investigated using graphene-based zinc oxide nanocomposites which are graphene oxide - zinc oxide (GO-ZnO) and reduced graphene oxide – zinc oxide (rGO-ZnO) nanocomposites. The synthesized composites were characterized by x-ray diffraction spectroscopy, scanning electron microscopy energy dispersion spectroscopy, Fourier transform infrared spectroscopy. The factors affecting the adsorption process, kinetics, adsorption isotherms and thermodynamic studies were carried out. Kinetic data showed that processes can be simulated with pseudo-second-order. Experimental results of equilibrium adsorption were tested with Langmuir, Freundlich and Dubinin-Radushkevich isotherms. The results show that Dubinin-Radushkevich fits the data better. Thermodynamic parameters, Gibbs free energy change (ΔG), enthalpy change (ΔH) and entropy change (ΔS), were calculated, indicating that the adsorption of U(VI) on GO−ZnO and rGO-ZnO are spontaneous while ΔH results show that endothermic in nature for GO-ZnO and exothermic for rGO-ZnO respectively.

**Keywords:** Adsorption, U(VI), Graphene oxide, Zinc oxide

## O-22 Antitumor Activity of Bromelain-Loaded Niosomes in Cancer Cells

**Ezgi Tut**[1], Özge Kozguş Güldü[2], Emin İlker Medine[2]
[1] Department of Biotechnology, Graduate School of Natural and Applied Sciences, Ege University, 35100 Bornova, Izmir, Turkey
[2] Department of Nuclear Application, Institute of Nuclear Sciences, Ege University, Izmir, TÜRKİYE

Bromelain is a protease mixture obtained from the pineapple stem or fruit. Bromelain is widely used for its wound and circulation healing, anti-inflammatory and immunomodular effects. In recent years, it has been shown in many cell types that it has anticancer properties due to its proteolytic activity. Trastuzumab is a monoclonal antibody specific for HER2+ positive cell lines. This chemotherapy drug is often used to treat breast and gastric cancer. In this study, bromelain was encapsulated into niosomes to preserve its proteolytic activity and prevent chemical and physical degradation, and specific targeting to HER2+ positive Human Epithelial Breast Adenocarcinoma (SKBR-3) cell line was performed with trastuzumab (herceptin) conjugation. Particle characterization was performed using Dinamic Light Scattering (DLS), Fourier Transform Infrared Spectroscopy (FTIR), X-ray photoelectron spectroscopy (XPS) and Transmission electron microscopy (TEM) analyses. Empty niosomes (Nio) 130±9 nm, Bromelain loaded niosomes (NioBr) 150±13 It showed a particle size of nm. It was observed that the zeta potential value associated with particle stabilization increased with bromelain loading and trastuzumab conjugation steps. FTIR and XPS analyzes were performed to confirm pegylation and trastuzumab conjugation.

**Keywords:** Bromelain, Niosome, Cancer, Trastuzumab, Drug delivery

## O-23 Radon Retention Capacities of Metal-Organic Frameworks (MOFs)

**Ceren Gündoğdu**[1], Mutlu İçhedef[1], Caner Taşköprü[1], Ümit H. Kaynar[2], Süleyman Gülcemal[3]
[1]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE
[2]Faculty of Engineering & Architecture, Fundamental Science, Bakırçay University, Izmir-TÜRKİYE
[3]Faculty of Sciences, Department of Chemistry, Ege Unıversity, Izmir-TÜRKİYE

According to international organizations, radon gas accumulation in buildings causes the second biggest risk in terms of lung cancer. For this reason, monitoring and reducing indoor radon concentrations is one of the most combative areas all over the world and it is significant to discover the materials that effectively adsorb radon gas. A solution to this problem begins to find new materials, and/or chemicals to be developed as natural or synthetic. Metal-organic frameworks (MOFs) have been used for radon capture due to their high physical adsorption capacity and high capture efficiency. Polymer-based composites enriched with MOF were produced by the electro-spin method. These materials were tested for their radon capture capabilities by the Solid State Nuclear Track Detectors (SSNTDs).

**Keywords:** Metal-organic frameworks (MOFs), Radon, Adsorption, SSNTDs, Electrospin method

## O-24 Evaluation of In Vitro Anti-Prostate Cancer Effects of Camptothecin Loaded Mesoporous Silica Nanoparticles

**Özge Kozguş Güldü**[1], Emin İlker Medine[1]
[1]Department of Nuclear Application, Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

There are standard clinical imaging methods such as computed tomography, magnetic resonance imaging, SPECT, PET, optical imaging and ultrasound. The target area can be evaluated as Dual Modality using two or more different imaging modalities with the development of multi-marked imaging probes. Therefore, it would be advantageous to develop one multifunctional imaging probe that can be detected with more than one imaging method at the same time. For this purpose, it is aimed to make a multifunctional probe to be able to show targeting cells to a specific antigen in Optical systems. Silica nanoparticles providing a unique platform for molecular imaging, cellular monitoring, and targeted diagnostic studies were synthesized using the reverse micelle method. Camptothecin (CPT) loaded fluorescent silica nanoparticles conjugated with PSMA were synthesized as a probe. In this work, mesoporous silica nanoparticles (MSN) as a multifunctional biocompatible probe wereused. Solution-based synthesis method was used that followed by structure directing agent removal. Indocyanine Green (ICG) used as the fluorescent dye was encapsulated to MSN and endowed relatively durable fluorescence characteristic. Camptothecin, a DNA topoisomerase I inhibitor, was loaded into the mesoporous silica nanoparticles. Characterization studies of the synthesized fluorescent nanoparticles were performed by FTIR, DLS and TEM. The synthesized fluorescent silica nanoparticles were conjugated with PSMA. After determination of conjugation yield via HPLC, in vitro applications were carried out on Human epithelial prostate carcinoma cell (LNCaP), Human epithelial prostate normal cell (RWPE1), Human epithelial prostate Adenocarcinoma cell (PC3). Cytotoxicity studies, apoptosis and fluorescent uptake studies were carried out. The hydrodynamic diameter of the particles was detected as 80 nm. It is seen that the synthesized MSNs have homogeneous size distribution. As a result of TEM analysis, average particle sizes were calculated as 30 nm. The loading capacity was found to be 85.4 ± 3.1 %. Cell viability was determined as 80% at 48h.

**Keywords:** Camptothecin, PSMA, Mesoporous silica nanoparticles, Prostate cancer cell line, Optical imaging

## O-25 Post-Radiation Effects in the Olefine-Containing Systems

**Islam Mustafayev**[1], Lala Jabbarova[1], Ramin Akbarov[2], Aida Mirzayeva[1]
[1]Institute of Radiation Problems, Baku, AZERBAIJAN
[2]Azerbaijan University of Architecture and Construction, Baku, AZERBAIJAN

Polymerization and post-polymerization processes in olefine-containing systems caused by radiation were studied. Preliminary studies were carried out in the example of radiolysis of a model hydrocarbon mixture - hexane/hexene system. Kinetics of the occurring processes were studied at the temperature T=20 °C, dose rate P=0.10 Gy/s, absorbed dose D=34-103 kGy and in 5, 10, 20 and 40 % concentrations of olefin in binary composition. As an indicator of the processes, the change of the liquid fuel's iodine number, density, viscosity, and molecular structure, as well as the kinetics of gas formation were studied. For simplicity, the radiolysis of the hexane-hexene mixture was initially considered. The dependence of the rate of the post-polymerization process on the olefin concentration and dosage in this simple system will guide the further development of research. Iodine number was studied in BRUKER MPA spectrometer, and molecular structure in "VARIAN 640-IR" spectrophotometer by IR-spectroscopy method at wavelengths of 4000-600 $cm^{-1}$. The density was determined by pycnometers according to GOST 3900–85. Viscosity was measured using VPZh-2 type viscometers according to GOST 33-66 and GOST 10028-81 The dependence of the viscosity on the dose regarding the change in the concentration shows that as the amount of olefin in the system and the dose of radiation increase, the viscosity also increases rapidly. As the concentration of unsaturated hydrocarbon in the system increases, the viscosity increases more rapidly, which can be explained by the polymerization process. At the same time, there is a decrease in the iodine number and the bands of the olefin bonds of the IR-spectrum. The varying degree of dose dependence is explained by the dose-dependent nature of the intermolecular interactions that determine viscosity. These indicators were measured again 1 month, 2 months and 3 months after the cessation of radiation. It was determined that the post-polymerization process takes place. The report discusses the mechanism of post polymerization processes.

**Keywords:** Hexane-Hexene mixtures, Gamma-radiation, Absorbed dose, Polimerisation, Post-polimerisation

## O-26 A Study on Adsorption Kinetic Models for $^{209}$Po Removal from Aqueous Solution Using Natural Zeolite

**Ümran Hicsonmez** [1], Sema Akyil Erenturk[2], Mahmoud A.A. Aslani[3], Aysun Ugur Gorgun[3]
[1]Manisa Celal Bayar University, Sciences-Arts Faculty, Department of Chemistry, Manisa, TÜRKİYE
[2]Istanbul Technical University, Energy Institute, Istanbul, TÜRKİYE
[3]Ege University, Institute of Nuclear Sciences, Izmir, TÜRKİYE

Alpha particles are released from heavy nuclei such as uranium, radium and thorium. α-emitting radionuclides pose a significant health risk when ingested. This way of damaging alpha particles makes them more dangerous than other types of radiation. The adsorption process is one of the most effective ways to remove toxic pollutants from aquatic environments. Adsorption is a process in which attractive forces associate an ion dissolved in solution to the surface of an adsorbent until equilibrium in adsorbate concentration is reached. Adsorption includes one or some of external diffusion, internal diffusion, surface diffusion and adsorption-desorption basic processes. Adsorption kinetics is an important factor that defines the efficiency of sorption. Adsorption kinetics basically describes the rate of adsorption of the solute and the residence time of the adsorbates at the solid-liquid interface. The rate of adsorption depends on the number of particles adsorbed on the adsorbent surface per second and the number of colliding particles per unit area per second. In this study, the kinetics of adsorption, which is effective in removing $^{209}$Po from aquatic environments, by using a natural zeolite as an adsorbent was investigated. The study of the adsorption kinetics of $^{209}$Po was carried out by interacting aqueous solutions containing $^{209}$Po with natural zeolite at different time intervals (5-240 min.). Initial and equilibrium activity concentrations of $^{209}$Po in aqueous solutions were counted with a ZnS(Ag) alpha scintillation counter. The experimental data were applied to some known kinetic models such as Pseudo-first-order, Pseudo-second-order, Elowich, Bangham, homogeneous particle diffusion and shell progressive models. Considering the correlation coefficients ($R^2$) of the aforementioned kinetic models, it was revealed that they were more compatible with the Pseudo-second-order model which is based on the assumption that the rate-limiting step is chemical sorption. In this condition, the adsorption rate does not depend on the adsorbate concentration but on the adsorption capacity. According to the results obtained, the adsorption capacity was 0.2273 µg $g^{-1}$ and the adsorption rate was 9.4E-14 µg $g^{-1}$ $min^{-1}$.

**Keywords:** Adsorption kinetics, $^{209}$Po, Zeolite

## O-27 The Radionuclide Content of Thermal Water in Azerbaijan

**Amina Mikayilova**[1]
[1]Institute of Radiation Problems, Baku, AZERBAIJAN

The territory of the Republic of Azerbaijan is rich in thermal waters with significant deposits in some parts of the Greater and Lesser Caucasus, the Absheron Peninsula and in the Talysh zone. The groundwater sources were discovered as a result of drilling wells for the exraction of oil and gas, as well as, thermal water wells in large areas of the Kura lowland and Khazar-Guba zones. The thermal waters in Azerbaijan are located in the mountainous parts of the Greater Caucasus (30-50 °C), the Guba-Khachmaz zone (40-85 °C) and the Absheron Peninsula (40-90 °C), the highlands of the Lesser Caucasus (30-74 °C), and the mountainous parts of the Nakhchivan Autonomous Republic (40-50 °C) and the Talysh zone (30-50 °C), and in some parts of the Lankaran (44-64 °C) and Kur-Araz plain (30-94 °C). One of the most characteristic features of thermal waters is their therapeutic value. The healing waters of Azerbaijan cure large-scale diseases. Many thermal and mineral waters of the Republic (Alasha, Istisu, Daridagh, Surakhani, Turshsu etc.) are widely used in the medical industry for the production of antibiotics and other therapeutic agents. It is known that the amount of radionuclides is not the same in the water in different areas and depends on the concentration of radionuclides located in different parts of the earth's crust. Major radioactive isotopes are found in the hilly parts of the earth. These are $^{40}K$, $^{87}Rb$ and radioactive decay products of $^{232}Th$, $^{238}U$, which have long been included in the Earth. Therapeutic thermal waters have some natural radioactivity that results from the dacay of uranium and thorium. Basically, $^{226}Ra$ and $^{228}Ra$ are found in thermal waters. Despite the use of the water with radon and radium at a certain degree (Rn-5nKu/l) for therapeutic purposes, even a small amount of radioactivity can pose a serious threat to human health. The radioactivity of the thermal water in Azerbaijan is less than the permissible limit and the studied underground water source does not pose a threat in terms of radioactivity when using.

**Keywords:** Thermal water, Radionuclide, Gamma-spectrometer, Marinelly

## O-28 GEANT4 Based Monte-Carlo Simulation Studies for Radiation Detection Purposed Detector Design at TENMAK-NÜKEN

**Alper Nazmi Yüksel**[1], Selen Nimet Gürbüz Güner[1], Erhan Aksu[1], Haydar Dişbudak[1], Sinan Kuday[2]
[1]Turkish Energy, Nuclear and Mineral Research Agency (TENMAK-NÜKEN), Ankara-TÜRKİYE
[2]University of Ankara, Ankara-TÜRKİYE

The scintillation detectors have been used for not only nuclear physics experiments but also high energy physics studies for the detection of ionizing radiation. Today, the significant studies are carried out by scientific community in order to develop and produce new scintillator materials, which have a quite important role regarding the design of new scintillator detectors. In this framework, studies on the design, development, production and improvement of basic properties for both ceramic (in-organic) and composite (organic) scintillator materials continue at the Nuclear Energy Research Institute (NÜKEN) of Turkish Energy Nuclear and Mineral Research Agency (TENMAK). In order to promote current studies and reveal necessary needed strategies regarding with possible future studies; Monte-Carlo-based simulation studies are also carried out by the Materials Research and Detector Technologies Group affiliated to the Nuclear Sciences and Materials Research Department at NUKEN. In this study, the results obtained from GEANT4 (the simulation toolkit developed by the CERN) based simulation studies carried out by taking into account ceramic and composite-based scintillator material candidate(s) whose development/production stages are ongoing by the Material Research and Detector Technologies Group are presented. In addition, the data obtained as a result of the simulation studies were analyzed by using the ROOT (CERN based software framework for data analysis) and analysis results were shared within the scope of this study. As the first step; in the presence of the same radiation source, absorbed photon number-energy spectrum comparisons were performed for the same scintillator material candidate with different geometric dimensions. As the next step, energy resolution performances were compared by getting absorbed photon number-energy spectrum for different scintillator materials which have the same geometric dimensions. As a further step, the absorption time values through the material of incident photons were investigated for different scintillator materials with same geometric dimension.

**Keywords:** Monte-Carlo simulations, GEANT4 simulation toolkit, Root software framework, Scintillation detector, Scintillator material, Material research.

## O-29 Low-Carbon Radiation-Chemical Processes of Oil- Refining

**Islam Mustafayev**[1], Nigar Guliyeva[1], Samira Aliyeva[1], Irada Haciyeva[2]
[1]Institute of Radiation Problems, Baku, AZERBAIJAN
[2]Azerbaijan University of Architecture and Construction, Baku, AZERBAIJAN

Annual emission of carbon dioxide is more than 50Gt in the world playing an important role in climate changes. About 3Gt of the emission is accounted for by the chemical industry. Therefore, the transition to a low-carbon chemical technology is currently considered a priority direction. In terms of carbon dioxide emissions, petrochemical processes, especially olefin and ammonia production, occupy a special place due to their high energy capacity. In these studies radiation-chemical transformations of cracking products oil, as well as tar and asphaltene fractions of oil, were studied in wide ranges of absorbed dose, dose rate and temperature. It has been used "MRX-γ-30" gamma radiation source and ELU-4 electron accelerator. The absorbed dose changed in the range of D = 0-200 kGy, and the dose rate in the range of P=8- 2400 Gy/sec. The yield of olefins and gases, the conversion rate of the initial substance, and the activation energy of these processes were determined as indicators of the processes. Under optimal conditions, the yield of olefins increased to 55%, the rate of hydrogen generation was W = (12.4-150.5)$10^{15}$ molec/ml sec, radiation-chemical yield hydrogen was G =2.5-21.3 molec/100 eV in dependence of temperature. At this time, the temperature of rapid occurrence of processes decreased by 250-300 °C. In addition to radiation-thermal processes, thermal processes were also studied for comparison. The ratio of the rate of radiation-thermal reactions ( Wrt) to the rate of thermal reactions (Wt) depends in a complex manner on the dose rate. The activation energy of radiation-thermal reactions is less than that of thermal reactions, which is due to the fact that the most energy-intensive stage occurs under the influence of radiation. The radiation resistance of the oil fraction of oil is 3-5 times lower than that of the tar fraction and 7-9 times lower than that of asphaltene. The fact that radiation-chemical processes can be carried out at low temperatures creates wide opportunities for reducing $CO_2$ emissions compared to thermal processes. Thus, the need for thermal energy obtained from combustion, which is necessary for raising the temperature of the system, decreases.

**Keywords:** $CO_2$-emissions, Oil, Radiation, Olefin, Gases

## O-30 Indoor Radon ($^{222}$Rn) Measurements and Assessment of Human Risk in the Dwellings of Edirne (Türkiye)

**Fatma Tezcan[1]**, Serpil Aközcan[1], Selin Özden[1]
[1]Department of Physics, Faculty of Arts and Sciences, Kırklareli University, Kırklareli, TÜRKİYE

Radon ($^{222}$Rn) is a colorless, odorless natural radioactive gas produced by $^{226}$Ra from the radioactive decay of $^{238}$U. Inhalation of radon and its daughter products is a major contributor to the effective radiation dose for the general population. Considering the importance of the subject, numerous indoor radon researchs has been carried out at an international level in recent years. In this preliminary study, an $^{222}$Rn survey and analysis for 29 dwellings in Edirne (Türkiye) was performed to secure the radiological safety of persons and to provide basic information on reduction of $^{222}$Rn exposure. Measurements of the radon concentration, together with temperature, pressure and humidity, were carried out using an AlphaGuard 2000 Pro monitor. The mean indoor radon concentration was within the safe limit of 300 Bq m$^{-3}$ as suggested by World Health Organization (WHO).

**Keywords:** $^{222}$Rn, Alphaquard, Edirne

## O-31 Synthesis of Activated Carbon-Nickel Oxide Nanocomposites and Investigation of its Performance in Immobilization of Uranium Ions via Adsorption Process

**Cansu Endes Yılmaz**[1], Ceren Kütahyalı Aslani[1], Emine Nostar Aslan[1], Mahmut A. A. Aslani [1], Yüksel Altaş[1]
[1]Ege University, Institute of Nuclear Sciences, İzmir, TÜRKİYE

Nuclear energy draws attention with its advantages due to the inadequacy of primary energy resources in the face of increasing energy demand and its negative effects on human health. In addition to the advantages of nuclear energy, it is very important to isolate the long-lived radioactive wastes generated from the nuclear fuel cycle. Multi-barrier systems are used in deep geological storage, which is considered suitable for isolating nuclear wastes from the biosphere. Engineering barriers layer in multi-barrier systems needs developing of new adsorbents which have high sorption capacity and radiation resistance. The aim of this study is to synthesize new adsorbents to use effectively in nuclear waste management by using the superior properties of activated carbon and nano metal oxides, which have good adsorbent properties individually. The usability of the obtained adsorbents in nuclear waste management was carried out by examining uranium adsorption. The parameters affecting the adsorption (contact time, pH, initial uranium concentration, and temperature) were investigated as a function of the central composite design by using the experimental design method. Activated carbon was synthesized from degreased waste canola sediments by the chemical activation method. Nickel oxide synthesis was carried out by hydrothermal method with varying temperature, time, and solid/liquid ratio. Activated carbon-nickel oxide nanocomposites were synthesized with the hydrothermal method by investigating 1:1, 1:2, and 2:1 AC:NiO mixture ratios. The average particle size of the synthesized most effective composite was measured as 17.64 ± 1.51 nm. The synthesized nanocomposites were characterized using FTIR, BET, SEM, XRD, and Raman analyses. As a result of uranium adsorption studies, optimum uptake capacity was calculated as 136.92 ± 4.7 $mg.g^{-1}$. Adsorption isotherms (Langmuir, Freundlich, and Dubinin-Radushkevich) and the thermodynamic properties were investigated. It was determined that the adsorption of uranium with activated carbon-nickel oxide nanocomposites is quite well defined by the Pseudo second-order rate equation.

**Keywords:** Activated carbon-nickel oxide nanocomposite, Uranium, Adsorption, Response surface Methodology

## O-32 Preparation of Gd-Doped Metal Oxide Nanofiber Composite Adsorbents by Electrospun Method and Radionuclide Adsorption Applications

**Ümit H. Kaynar**[1], S. Çam Kaynar[2], E. Ekdal Karali[3], M. Ayvacıklı[4], N. Can[5], İ. Gözde Kaptanoğlu[6]
[1]Izmir Bakırcay University, Faculty of Engineering and Architecture, Department of Fundamental Sciences, Menemen, Izmir-TÜRKİYE
[2]Manisa Celal Bayar University, Faculty of Arts and Sciences, Department of Physics, Muradiye-Manisa-TÜRKİYE
[3]Ege University, Institute of Nuclear Sciences, Izmir-TÜRKİYE
[4]Manisa Celal Bayar University, Hasan Ferdi Turgutlu Technology Faculty, Mechatronics Engineering, Turgutlu-Manisa-TÜRKİYE
[5]Jazan University, Physics Department, P.O. Box 114, 45142 Jazan-KINGDOM OF SAUDI ARABIA
[6]Ege University, Institute of Science, Department of Materials Science and Engineering, 35100, Bornova, Izmir-TÜRKİYE

The waste problem caused by the medical and industrial use of nuclear materials is evaluated differently from other wastes because they can harm human and environmental health. In particular, due to the amount of radioactivity, physical and/or chemical condition, it sometimes requires emergency intervention methods. Obtaining safe, economical and environmentally friendly effective materials that will adapt to emergency and rapid use methods for radionuclide removal is one of the most important research topics of today. In this study, the adsorption properties of nanofiber composite material with Gd metal ion doped nano $ZrO_2$ (Gd/nano-$ZrO_2$) synthesized by microwave assisted ignition method in order to remove Thorium (IV), one of the most important radionuclides, from aqueous environment will be investigated.

Acknowledgment The authors acknowledge grants from the Scientific and Technological Research Council of Turkey (TUBITAK, project number: 1001-120M235).

**Keywords:** Nano Gd-$ZrO_2$, Electrospun, Nano fiber, Adsorption, Radionuclide

## O-33 Determination of Optimum Conditions for the Extraction and Separation of Lanthanum, Cerium, Yttrium and Thorium Using Taguchi Method

**Abdoul Rachid Chaibou Yacouba**[1], A. Enes Oral[2], Şenol Sert[2], Gozde Kaptanoglu[2], D. A. Türközü[3], Ibrahim Natatou[4], Sabriye Yuşan[2], Şule Aytaş[2]
[1]Agadez University, Faculty of Sciences, Dpt. of Chemistry. Agadez, NIGER
[2]Ege University, Institute of Nuclear Sciences, 35100, Bornova-Izmir, TÜRKİYE
[3]Yuzuncu Yil University, Engineering Faculty, Environmental, Eng.Dept. Van, TÜRKİYE
[4]Abdou Moumouni University, Faculty of Sciences, Dpt. of Chemistry. Niamey, NIGER

Taguch's method was applied to determine the optimum conditions for the extraction and separation of lanthanum, cerium, yttrium and thorium using tributylphosphate (TBP), trioctylamine (TOA) and trioctylphosphine oxide (TOPO). The effect of various parameters such as salt type ($KNO_3$, KSCN, KI) and their concentrations, nitric acid concentration, pH of solution, TOPO concentration, synergism effect and stripping solutions (HCl, $H_2SO_4$, $HNO_3$) were investigated on the La (III), Ce (III), Y(III) and Th (IV) extraction efficiency and separation. It was found that the optimum results were obtained with TOPO. The extraction efficiency and distribution coefficient of La (III), Ce (III), Y(III) and Th (IV) increased by increasing the salt concentration and followed this sequence of anions adding ($SCN^- > I^- > NO^{3-}$). Under this conditions 0.5 M $HNO_3$, 0.1 M TOPO and $10^{-1}$ M KSCN, the extraction efficiency of all metals reached 85%. Increasing $[H^+]$ in aqueous solution has a decreasing effect and suggested that the extracted species in organic phase were expressed by $M(NO_3)_3(TOPO)_3$ (M = La, Ce, Y) and $Th(NO_3)_4.2TOPO$.

**Keywords:** Taguch's Method, Lanthanum, Cerium, Yttrium, Thorium, Extraction, Separation

## O-34 OSL Dating of a 150-Year-Old Cultural Heritage in Turkey

Ülkü Rabia Yüce[1], **Pınar Çelik[1]**

[1]Turkish Energy, Nuclear and Mineral Research Agency, Nuclear Energy Research Institute, Ankara, TÜRKİYE,

In this study, Optical Stimulated Luminescence (OSL) age determination was performed of brick samples belonging to a two-piece structure built as a main building and a warehouse, which was included in the cultural heritage to be protected since it is one of the early examples of the reinforced concrete construction system in Turkey. In order to carry out the renovation and conservation works of this structure, which is also seen on the old Istanbul maps of the early 1900s, the need to scientifically prove that the main building and warehouse parts were built in the same period arose. In this context, the outer surfaces of two separate brick samples taken from the main building and warehouse parts were scraped approximately 5 mm, and the luminescence measurements of coarse-grained quartz minerals extracted from the middle parts were measured using the Single Aliquot Regeneration (SAR) protocol. Equivalent doses in bricks were determined as 0.468 ± 0.003 Gy and 0.489 ± 0.003 Gy for the main building and warehouse, respectively. The amounts of Uranium-238, Thorium-232 and Potassium-40 in the samples were measured using the gamma spectrometer method. Considering the humidity parameters and cosmic ray dose rate contributions, the annual dose rates of the samples were calculated as 3.265±0.152 Gy/ka for the main building and 3.258±0.153 Gy/ka for the warehouse. The determined equivalent doses were divided by the annual dose rates and the OSL ages of the samples were determined as 143 ± 10 years and 150 ± 10 years for the main building and the warehouse, respectively. Thus, it was concluded that the main building and the warehouse parts of the building were built in the same period and should be restored together. As far as we know, these examples are the youngest examples of immovable cultural heritage in our country, whose age is determined by a physical technique, and this study is of great importance in this respect.

## O-35 Numerical Modeling of Groundwater Radionuclide Transport with Finite Difference Based Method of Lines

Tayfun Tanbay[1], **Ahmet Durmayaz**[2]
[1]Bursa Technical University, Bursa, TÜRKİYE
[2]Istanbul Technical University, İstanbul, TÜRKİYE

The high level radioactive wastes emanating from nuclear power plants are a major source of public concern. Geological disposal of these wastes is a common approach in radioactive waste management, however, waste canisters are likely to deteriorate and the consequential release of radionuclides may lead to the contamination of the groundwater and transportation of harmful material to the biosphere. In such a situation, accurate modeling of radionuclide transport with groundwater is vital for the radiological safety assessment of underground waste repositories. In this work, the advection-dispersion equation that takes into account decay reactions is numerically solved with the finite difference based method of lines (FD-MOL) to simulate groundwater radionuclide transport in one-dimensional Cartesian and radial geometry. Finite difference orders of 1,2,…,8 are used for spatial approximation, while explicit and implicit schemes are employed adaptively for temporal discretization. Three cases are considered, and the performance of the FD-MOL is investigated in detail to determine the accuracy, stability and convergence rate of the method. Calculations are performed with arbitrary precision arithmetic, and the effect of precision on the characteristics of the FD-MOL is also examined. Maximum and root mean square (RMS) errors in radionuclide normalized concentrations are chosen as the performance criteria, and the results show that the FD-MOL provides accurate and stable numerical solutions with both explicit and implicit schemes. Coarse temporal grids can be utilized with the implicit approach, for instance, in the case of $^{234}U \rightarrow ^{230}Th \rightarrow ^{226}Ra$ problem, a temporal mesh of 1000 years with the finite difference order of 2 and 400 spatial nodes yields RMS errors of $6.7\times10^{-5}$, $4.3\times10^{-4}$ and $1.0\times10^{-3}$ in $^{234}U$, $^{230}Th$ and $^{226}Ra$ normalized concentrations, respectively.

**Keywords:** Groundwater radionuclide transport, Finite difference, Method of lines, Adaptive temporal differencing, Explicit and implicit schemes

## O-36 Characterization and Luminescent Properties of Natural Amazonite

**Eren C. Karsu Asal**[1]
[1]Celal Bayar University, Manisa, TÜRKİYE

In this work, the characterization and luminescence properties of triclinic natural amazonite aliquots from Tangir Valley, Gilgit-Pakistan are studied. The phase and elemental analysis of this alkali aluminosilicate was characterised by XRD and XPS, respectively. The surface morphology and particle size of this potassium-rich silicate were identified by scanning electron microscopy. The luminescence properties were investigated using photoluminescence and thermoluminescence. In addition, the lifetime of the PL emission measurements was estimated. Both the fading and isothermal decay (ID) of the TL glow peak were investigated. All measurements were performed on three samples and representative results are presented. Aliquots were irradiated with a beta dose of 1.2 Gy/min and stored under dark conditions for up to 7 days, 4 h, performing 50% glow with respect to the direct reading. The activation energy of the peak obtained. The structural studies of the natural amazonite using the XRD technique show a triclinic phase of the microcline. The XPS measurements show that the silicate is chemically composed of $SiO_2$, C-C or C-H, metal oxide, $Al_2O_3$, SiC, carbide and metal $SiO_4$. From the SEM patterns, the particle sizes of the mineral are in the range of 1-10 µm and have a complex structure with multiple planar defects. The photoluminescence spectra of the mineral show a broad emission band from the UV to the red region with strong blue-green emission under UV excitation. The emission intensities were strongly dependent on the host lattice composition, impurities, and morphology of the mineral. The natural amazonite aliquots showed bright, long-lasting emission with a duration of 2 ms when excited at 340 nm. The fading studies indicate Anomalous Fading (AF), which is part of the tunnelling effect. Matching results were obtained using the ID technique. Both the AF and ID results indicate the presence of a tunnelling phenomenon. The natural amazonite mineral from the Talgir Valley has not been analysed so extensively by luminescence and characterization studies. Therefore, its believed that this is the first attempt at a comprehensive combination of luminescence and characterization studies on natural amazonite aliquots from the Talgir Valley.

**Keywords:** Amazonite, K-rich Feldspar, Luminescence, Fading, Characterization

## O-37 $^{201}$Tl Production Process

**Berna Yıldız Akdağ**[1]
[1]Nuclear Energy and Research Agency, NÜKEN TENMAK, Ankara, TÜRKİYE

$^{201}$Tl is a unique radiopharmaceutical for imaging of cardiac problems using single photon emission computed tomography (SPECT) techniques for the diagnosis. It is solely produced in Proton Accelerator Facility located in Ankara and operated under Turkish Energy, Nuclear Mineral Research Agency. Besides national demands; we supply $^{201}$Tl as radiopharmaceutical form to other regions of the world. The radionuclide $^{201}$Tl is obtained by proton irradiation of an enriched $^{203}$Tl target in a cyclotron. After target electroplating by enriched isotope the irradiation by proton beam takes place in solid target irradiation vault. Proton beam energy is 30 MeV which is the whole Middle east's only. Nuclear reaction is $^{203}$Tl (p, 3n) $^{201}$Pb. Production from $^{201}$Pb to $^{201}$Tl is carried out on two different purification modules. In chemistry-1, the formed $^{201}$Pb is separated from enriched $^{203}$Tl after dissolution of the irradiated target. After decay time of $^{201}$Pb; in chemistry-2 purification module, the separation of $^{201}$Tl from the remaining $^{201}$Pb EDTA. Cation exchange column purification, oxidation then solvent extraction; reduction then back-extraction in 0.1 M HCl steps by turn on the module. The $^{201}$TlCl is transferred to the patient dose distribution unit by tubing. The radiopharmaceutical dose on the production license is 1mCi/1 mL. The produced bulk solution is counted in dose calibrator in quality control laboratory. According to the activity, the bulk solution is diluted by water for injection until 1mCi/1 mL. In one patient vial is filled totally 10 mL. The injectable $^{201}$Tl patient dose must have a pH between 4 and 7; be isotonic (have the same osmotic pressure as blood); be sterile (no microorganisms). Radionuclidic purity is analysed by high purity Ge detector ($\geq$ %97,0) and identification of $^{201}$Tl peaks at 135 keV and 167 keV. Radiochemical purity by electrophoresis should be ($\geq$ %95,0), Tl concentration should be $\leq$ 10ppm considering toxicity. The sample is between 250-350 mOsmol/kg for blood pressure. Bacterial endotoxin and sterility test are essential for quality control tests. The results must be in accordance to the European pharmacopoeia and laboratory conditions are classified area with the GMP rules.

**Keywords:** $^{201}$TlCl, Radiopharmaceutical, SPECT, Cyclotron, GMP

## O-38 Opium Poppy Oil and Alginate Bigel System for Neodymium Recovery

**Cem Gök**[1], Yusuf Özcan[1], Esranur Kızılhan[1], Dicle Erden Gönenmiş[1]
[1]Pamukkale University, Denizli, TÜRKİYE

Bigel is a structure formed by the combination of organogel and hydrogel. This structure consists of alginate as hydrogel and beeswax as organogel. The synthesized bigel structure was described by Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM), Energy Distribution Spectrometer (EDS) and Mapping. The synthesized bigel was used as an adsorbent for neodymium ions in aqueous solution. This adsorbent material showed high efficiency and very high biosorption capacity in the removal and recovery of neodymium. As a result, the adsorption equilibrium time, temperature and pH were reached at 120 minutes, 25 °C and 4,0 pH, respectively. Isothermal models were applied to describe the biosorption of neodymium ions by bigel. Thermodynamic parameters such as biosorption enthalpy, entropy and free energy transition have been also calculated.

**Keywords:** Neodymium, Biosorption, Bigels, Recovery, Isotherm

## O-39 Mechanical and Elastic Properties of Alternative Glass Compositions for Waste Vitrification by Ultrasonic Technique

**Sema Erentürk**[1], Filiz Gür[2]
[1]Istanbul Technical University, Energy Insitute, Istanbul-TÜRKİYE
[2]Ege University, Institute of Nuclear Sciences, Bornova-Izmir-TÜRKİYE

The vitrified nuclear waste form is one of the most promising materials for radioactive waste management applications. Glass is the most preferred material for the immobilization of waste forms because of its good chemical durability, sufficient mechanical properties, and radiation stability. Borosilicate glasses are well characterized for high-level waste immobilization in many studies that investigated their chemical and mechanical stability of them. Other borate-based glass compositions have been used in several studies to improve their performance of them on radioactive and industrial wastes in recent years. One of the non-destructive techniques used to predict material properties today is to use ultrasonic waves. Studies on the elastic properties which are affected by the rigidity of the structure have given significant information about the structure of the glasses. Glasses have only two independent elastic constants: longitudinal and shear elastic moduli obtained from the longitudinal and shear sound velocities and density of the glass. In recent years there have been interesting studies on elastic moduli of glasses measuring the ultrasonic velocities to investigate the structure of the glasses influenced by many physical parameters. Different parameters such as elastic moduli, Young's modulus, Vickers hardness, and micro-hardness of the glasses can be obtained to estimate of mechanical strength of the glasses. The main goal of this study is to focus on alternative glass compositions for the vitrification process of nuclear wastes and to present the elastic and mechanical properties of these new glass compositions using ultrasonic techniques. All glass compositions ($Na_2O$-$B_2O_3$, NaO-$P_2O_5$-$B_2O_3$, NaO-PbO-$B_2O_3$, and $Na_2O$-$P_2O_5$-PbO-$B_2O_3$) were prepared using a conventional melt-quenching method. Elastic properties have been investigated using sound velocity measurements at 4 MHz. Elastic properties of the glasses at room temperature in the air were determined from measurements of longitudinal (Vl) and shear (transverse) (Vs) ultrasonic velocities. The values of Young's modulus (E), shear modulus (G), bulk modulus (K), and Poisson's ratio (n) were calculated from the values of Vl and Vs. The density of the glasses studied was increased with an increase in Cs and Sr content mol.%. The waste capacity of 35% for sodium borate glass containing Sr has been reached. The increase of the ultrasonic velocities (both longitudinal and shear), temperature values of (Debye, softening, latent heat of melting), and diffusion constant with increasing SrO content in sodium borate glasses, are attributed to the increase in connectivity of the network structure. Elastic moduli, Poisson's ratio, and cross-link density are observed to increase with increasing SrO content, indicating the increase in rigidity of the network structure. In glasses containing Cs, the best ratio was achieved at 20% Cs. Elastic modulus, Poisson ratio, and crosslink density were found to be lower in glasses containing Cs than in glasses containing Sr.

**Keywords:** Vitrification, Cs and Sr wastes, Ultrasonic test, Mechanical properties, Elastic properties

## O-40 Application of Greek Mineralsf for Eu, Cs and Co-Removal from Aqueous Solutions; The Effect of Irradiation

**Iro Dianellou** [1], Filippos Karantoum Anis[1], Panagiotis Tsamos[1], Fotini Noli[1]
[1]Aristotle University, Thessaloniki-GREECE

Zeolites and clay minerals are successfully applied as permeable reactive barriers (PRB) in radioactive waste management. In this work the sorption properties of Greek bentonites and zeolites have been investigated in raw form and after irradiation for removal of radionuclides Eu, Cs and Co from aqueous solutions. The irradiation was performed using an $^{241}$Am source for different time (two and five days) and the sorption experiments were undertaken in aqueous solutions using the batch system. The experiments were performed using as tracers $^{152}$Eu, $^{137}$Cs and $^{60}$Co and γ-ray spectroscopy. The effect of different parameters such as pH, concentration, competitive ions ($Na^+$) and temperature (20, 25, 35, 45 °C), on the sorption onto bentonites and zeolites was also studied. The structural changes of the sorbents were examined before and after irradiation as well as before and after sorption studies through XRD analysis and scanning electron microscopy (SEM-EDS). The sorption isotherms were satisfactorily reproduced by the Langmuir and Freundlich equations as well as kinetic experiments and calculation of the thermodynamic parameters (ΔH, ΔS˚ and ΔG°) provide information for the sorption behavior of the tested materials. As it was concluded the sorption capacity was slightly affected by irradiation and the process was spontaneous and exothermic in general. The environmental compatibility using the Toxicity Characteristic Leaching Procedure proved that the materials investigated for the selected radionuclides can be safely disposed in the environment.

**Keywords**: Irradiation, Sorption, Bentonite, Zeolite, Gamma Ray

## O-41 Aerial Monitoring System for Radiation Detection

**Ali Akgöz**[1], Muhammet Barık[1]
[1]Turkish Energy, Nuclear and Mineral Research Agency, Ankara-TÜRKİYE

The increasing complexity, availability and adaptability of Unmanned Aerial Vehicles (UAVs) have made them an emerging capability for radiation detection. This presentation's focus will be on introducing the prototype UAV radiation detector which developed and produced by R&D department of Nuclear Energy Research Institute. Explanations on production steps, electronics design, detectors used in the prototype, communication within the prototype, communication with ground, software developed for ground station, geospatial analysis of retrieved data and a discussion of a survey result will take part in the presentation.

**Keywords:** Drone radiation detection, Unmanned aerial vehicle, Radiation monitoring, Radiation detectors, Geospatial analysis

## O-42 The Exchange of Radon Gas Concentration Along Manisa Fault

**Caner Taskopru**[1], Mutlu Ichedef[1], Alparslan Enes Oral[1], Muslim Murat Sac[1], Hasan Sözbilir[2]
[1]Ege University, Institute of Nuclear Sciences, Bornova-Izmir-TÜRKİYE
[2]Dokuz Eylül Univ., Faculty of Engıneerıng, Dept. of Geological Engıneerıng, Izmir-TÜRKİYE

Rocks and soils form the main source of radon which is a radioactive noble gas. For this reason, radon is the most useful and studied natural gas, providing information about the earth's movement. Additionally, faults and fractures play a prominent role in the transport of radon gas. The radon gas concentration at the Manisa fault along and the vertical stations to the fault were monitored in this study. The study was carried out using LR-115 type 2 radon detectors with monthly periods for two years. As a result of the study, it was seen that the radon levels in the measurement stations closest to the fault were approximately 5-10 times higher than those far from the fault. With this study, the soil gas radon levels of the region were determined for the first time.

**Keywords:** Radon concentration, Manisa fault, LR-115 Type II Detector

## O-43 Dispersion of Radionuclides and Heavy Metals from Phosphogypsum Stacks in Soil and Plants

**Fotini Noli**[1], Maria Sidirelli[1], Panagiotis Tsamos[1]
[1]Aristotle University of Thessaloniki-GREECE

Phosphogypsum is classified into NORM (Naturally Occurring Radioactive Materials). It contains radionuclides such as $^{238}U$, $^{226}Ra$ and $^{232}Th$, and also heavy metals such as Pb, Zn, Fe, Mn, Cu, Ni, Cd and As which are dispersed in different form and concentrations and can be dangerous for humans. Determination of the concentration of radionuclides and heavy metals in soils and plants near a phosphate fertilizer production unit and phosphogypsum stucks at Northwestern Greece was carried out. The activities of the natural radionuclides $^{238}U$, $^{226}Ra$ and $^{232}Th$, as well as $^{137}Cs$ and $^{40}K$ were determined by γ-spectroscopy. The uranium isotopes $^{238}U$ and $^{234}U$ were determined by α-spectroscopy, while the metals through the techniques of neutron activation analysis and polarography. Transfer and enrichment factors were estimated as well as radiation risks and the results led to the conclusion that the radiation hazard in the investigated region was moderate.

**Keywords:** Phosphogypsum, Radioactivity, Uranium, Heavy metals, Soils, Plants

## O-44 Continuous Ground Measurements in Rila Mountain by INRNE-BAS

**Nina Nikolova**[1], Todor Arsov[1], Georgi Georgiev[1], Nikola Serafimov[1], Hristo Angelov[1], Dimitar Tonev[2]

[1]Basic Environmental Observatory Moussala, Institute For Nuclear Researches and Nuclear Energy, Bulgarian Academy of Sciences, 72 Tsarigradsko Shose Blvd., 1784 Sofia, BULGARIA

[2]Laboratory of Cyclotron Physics, Institute For Nuclear Researches and Nuclear Energy, Bulgarian Academy of Sciences, 72 Tsarigradsko Shose Blvd., 1784 Sofia, BULGARIA

One of the scientific and experimental bases of the Institute for Nuclear Research and Nuclear Energy within the Bulgarian Academy of Sciences is Basic Environmental Observatory Moussala. It location is on the highest pic of Balkan Peninsula named Moussala. The station allows a real-time data with free access via internet on the web: https://beo-db.inrne.bas.bg . The obtained data show an information about current state of the air pollution and are of high importance of a prediction the population in a case of emergency as radiation accidents, forest fires, eruption of the volcanoes and chemical contamination.

**Keywords:** Remote sSensing, Mountain air, Bulgaria

## O-45 Quantifying the Effect of Wildfire on Soil Element Concentrations in Mediterranean

Ayse Nur Esen[1], Nikita Yushin[2], Dmitrii Grozdov[2], Cihan Yıldız[3], Inga Zinicovscaia[2], **Sevilay Haciyakupoglu**[1], Sema Erenturk[1], Tolga Gorum[3]
[1]Energy Institute, Istanbul Technical University, Istanbul-TÜRKİYE
[2]Department of Nuclear Physics, Joint Institute for Nuclear Research, Dubna-RUSSIA
[3]Eurasia Institute of Earth Sciences, Istanbul Technical University, Istanbul-TÜRKİYE

Every year, wildfires burn huge forest regions all around the world. Climate change has been a key factor in increasing the risk and extent of wildfires. Wildfire events can remobilize elements into the water-sediment-soil-biota system. This could be especially important in regions with high background contents of elements. Increased risk to human health and ecological receptors may be associated with the mobilization of trace elements following wildfire. This study was carried out in an area close to the Mediterranean coastal region. Soil samples of 0-30 cm soil depth were collected from 70 cores along transects from burned (north and south-facing slope) and unburned areas (south-facing slope) in North Adrasan, Kumluca (Antalya) to investigate the impact and consequences of the 2016 wildfire on element concentrations in soil. Samples were analyzed by neutron activation analysis (NAA) for the macronutrients Ca, Mg and K, micronutrients Fe, Mn and Zn, and potentially toxic elements As, Co, Cr, Ni and V at the IBR-2 reactor of Frank Laboratory of Neutron Physics of the Joint Institute for Nuclear Research in Dubna, Russia. The fire-related enrichment factor (EFWF), which is calculated as the ratio between element concentration in burned soil and unburned soil from the south-facing slope, was used to quantify the impact of the wildfire on element concentrations. Burned soils on the south-facing slope had higher concentrations of Co, Cr, Fe, Mg, Mn, Ni and Zn. Particularly, Cr and Ni with EFWF=29 were the elements that increased the most noticeably in burned soils (south-facing slope). Additionally, Co, Mg, Fe, Mn, and Zn all have EFWF values greater than 1.5. In the case of As and V, 0.5<="" p="" style="box-sizing: border-box;">

**Keywords:** NAA, Soil, Wildfire, Post-fire, Element

## O-46 Preparation of Xylenol Orange and Alginat Based Composite to Detect Strontium using RGB Coordinate Method

**Alparslan Enes Oral**[1,2], Şule Aytaş [1], Sabriye Yuşan[1], Fatma Nil Ertaş[3]
[1] Ege University Institute of Nuclear Science, Bornova-Izmir-TÜRKİYE
[2]Institute for Nuclear Waste Disposal of The Karlsruhe Institute of Technology (KIT-INE) Karlsruhe- GERMANY
[3]Ege Unıversıty Fac. of Science, Dept. of Chemistry, Bornova-Izmir- TÜRKİYE

Due to nuclear weapon tests and nuclear accidents, Sr-90 and Cs-137 accumulate in waters around the world (seas, lakes, and rivers). Sr-90 radioisotope is chemically similar to 2A element calcium, which is commonly found in bone and muscle tissue of animals. Since it is similar to calcium, Sr-90 radioisotope can easily accumulate in the tissues and cause health problems by radiating in the body. Studies in the field of detection and removal of the Sr-90 radioisotope have gained great urgency and importance today. Various functionalized materials have been developed and reported for the selective detection and removal of radionuclides from aqueous solutions.

In this study, we prepared alginate beads modified with Xylenol Orange probe molecule to detect strontium ions. As a probe molecule, Xylenol Orange was immobilized on alginate beads. Color changes of the beads in the presence of strontium ions were quantitatively determined using RGB (red, green, blue) color coordinate values. RGB values of Xylenol Orange-alginate beads were evaluated using ImageJ (Image Java). Optimization of suitable conditions for the colorimetric detection of strontium ions was investigated. The effect of solution pH, strontium concentration in solution and reaction time were optimized. The colorimetric coordinate method provides a convenient and simple technique for metal ion detection with the naked eye. This method, which can be easily observed with the naked eye, is suitable for monitoring target metal ions and potential application in on-site detection due to its simplicity and portability. This colorimetric detection of the strontium ion is numerically analyzed using portable devices such as a desktop digital scanner and a smart phone camera to determine the RGB value. We believe it is a simple, convenient, and fast detection method, as it can be a potential candidate for practical applications such as on-site testing and monitoring of elements.

Acknowledgement: This work was financially supported by Ege University, Scientific Research Foundation under the Grant No. FDK-2020-22104. Alparslan E. ORAL sincerely acknowledges The Scientific and Technological Research Council of Turkey (TUBITAK) for providing necessary fellowships.

**Keywords:** Strontium, Xylenol orange, Alginate, RGB color coordinate

## O-47 Use of The Fallout Radionuclides Technique for Soil Erosion Assessment in Northwest Morocco and in Western Turkey

**Meryem Moustakim**[1], Moncef Benmansour[2], Müslim Murat Saç[1], Yassine Al Masmoudi[3], Asmae Nouira[4], Azouz Benkdad[4], Brahim Damnati[5]
[1]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE
[2]National Center for Energy Sciences and Nuclear Techniques (Cnesten), Rabat-MOROCCO
[3]Faculty of Sciences, Choaïb Doukkali University, El Jadida-MOROCCO
[4]National Center of Nuclear Energy, Sciences And Technologies (Cnesten), Rabat-MOROCCO
[5]Faculty of Sciences and Techniques of Tangier, Abdelmalek Essaadi University-MOROCCO

The western extremity of Anatolia and the Northwest of Morocco are two areas with typical Mediterranean climate and close to the European side. The combination of climatic factors and topography submitted the two areas to severe soil erosion. The fallout radionuclides approach was used in both areas to obtain reliable datasets on the magnitude of the phenomenon in some agricultural fields located within Nakhla and El Hachef watersheds in Northwest Morocco and in Yatagan and Gediz basins in western Turkey. Based on the Caesium-137 measurements and the MBM2, soil erosion rates ranged from 6.2 and 91.2 t $ha^{-1}$ $yr^{-1}$ within the Nakhla field and ranged from 2.2 t $ha^{-1}$ $yr^{-1}$ and 78.9 t $ha^{-1}$ $yr^{-1}$ in El Hachef sites over the period (1954-2017). Comparing the obtained mean soil erosion rates with those obtained in previous studies, the intensity of soil erosion significantly decreased due the implemented soil erosion control strategy in the Nakhla watershed and due to some beneficial changes in land use consisting of more frequent fallow periods and crop rotation practice in both the Nakhla and El Hachef study sites. At Kayışalan within the Yatagan basin where there are intensive agricultural activities and based on the PM and the SMBM, the mean annual erosion rates were obtained to be 65 and 116 t $ha^{-1}$ $yr^{-1}$ respectively. The obtained high erosion rates pointed out the significant tillage contribution to soil loss. Gediz basin is also one of the regions where intense agricultural activities take place in Western Turkey. Erosion rates varied from 15 to 28 t $ha^{-1}$ $year^{-1}$ with the PM, and from 16 to 33 t $ha^{-1}$ $y^{-1}$ with the SMBM. The excess Lead-210 ($^{210}$Pbex) technique was used to generate data on soil redistribution rates over a longer time window of 100 years. In the Nakhla site, erosion rates ranged between 0.1 and 203.9 t ha−1 $yr^{-1}$, whereas in the studied cultivated sites within Gediz basin, the results of the $^{210}$Pbex technique are found to vary between 1.16 and 176.89 t $ha^{-1}$ $yr^{-1}$.

**Keywords:** Soil Erosion, Caesium-137, Excess lead-210, Northwest Morocco, Western Turkey

## O-48 Investigation of Natural Radioactivity in Drinking Water Sources in South-Central Bulgaria

**Elena Geleva**[1], Dimitar Tonev[1], Bozhidar Slavchev[1], Hristo Protohristov[1], Blagorodka Veleva[2], Lyuben Dobrev[1], Desislava Dimitrova[1], Anguel Demerdjiev[1]
[1]Institute for Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences-BULGARIA
[2]National Institute of Meteorology and Hydrology-BULGARIA

The purpose of this study was to determine the activity concentrations of naturally occurring radionuclides in drinking water from certain sources in South-Central Bulgaria. The survey is focused on three radionuclides, which are most important from the point of view of public health in Bulgaria, because of their high toxicity and radiotoxicity in drinking water, namely U-238, U-234 and Po-210. The activity concentrations of U-238, U-234 and Po-210 varied from 79 to 826 mBq/L, 130 to 1623 mBq/L and < 0.5 to 25.5 mBq/L, respectively. A state of radioactive disequilibrium between U-234 and U-238 in water was detected. The U-234/U-238 activity ratio varied between 0.93 and 3.21. Based on the radionuclide activity concentrations total annual effective ingestion doses for adults, as well as contribution of each particular radionuclide to the total doses, were assessed and discussed. Contributions of the consumed waters to the annual effective dose from U-238, U-234 and Po-210 varied from 8.85 to 62.5 μSv/y with a mean of 46.1 μSv/y. The lowest contribution to the annual effective doses was found for Po-210 and the highest for U-234. The results show that the annual effective doses of ingestion of these waters are below the individual dose criterion of 100 μSv/y according to the recommendations of the World Health Organization. The obtained new results are used to assess the radiation status of the investigated water.

Acknowledgements: The research has been supported by Bulgarian Science Fund under Contract No. KP-06-N44/1, 27.11.2020 and the National Science Program “Environmental Protection and Reduction of Risks of Adverse Events and Natural Disasters”, approved by the Resolution of the Council of Ministers No 577/ 17.08.2018 and supported by the Ministry of Education and Science of Bulgaria (Agreement No D01-279/03.12.2021).

**Keywords:** Drinking water, U-238, U-234, Po-210, Annual effective dose

## O-49 Investigation of The Effects of Some Experimental Factors on Radiation Beam Intensity in Mammography

**Engin Aşlar**[1]
[1]Institute of Nuclear Sciences, Ankara University, TÜRKİYE

The mammography technique is accepted as the most effective technique developed for the prevention of breast cancer in its early stages, which is seen as second among cancer-related deaths among women worldwide. The investigation of the variations in radiation beam intensity is very important both for performing the dosimetric evaluation accurately and also for developing quality control processes by obtaining a better understanding of system performance. In this study, the heel effect caused by the tilted anode in the X-ray tube, the presence of a compression pedal, and entrance surface dose (ESD) for phantom belonging to different glandular/adipose ratios have been investigated using thermoluminescence dosimeters TLD-100. First, the dosimeters were calibrated separately for three different tube potentials of 24, 28, and 32kVp using a 10X6-6M Radcal parallel plate ionization chamber, and corresponding correction factors were assigned for each energy. The heel effect has been investigated for each point by making detailed mapping with a 1.5 cm distance between dosimeters covering an irradiation area of 18x22 $cm^2$. The variation of ESD values has been investigated using the BR-12 phantom (12.5×10cm2) for 2, 4, 5, and 6 cm phantom thicknesses belonging to 30%/70%, 50%/50%, 70%/30% glandular/adipose ratios for the three tube potentials. As a result of heel effect, the radiation beam intensity values decreased by ~8% at 6cm and by ~85% at 18cm from the breast wall. On the other hand, the compression pedal reduced the intensity value by ~25% compared to without it. The ESD values increased as the glandular ratio (from 30% to 70%) in phantom increased. The results obtained in the present study may provide important outputs for use in dosimetric studies in the field of mammography.

**Keywords:** Heel effect, Compression pedal, Entrance surface dose (ESD), Gglandular

## O-50 Environmental Assessment of Natural Radionuclides and Trace Elements Around Seyitömer Coal Fired Power Plant

**Banu Yoho**[1], Erkan Guler[2], Buket Canbaz Ozturk[3], Michael Yoho [4]
[1] Ege University, Institute of Nuclear Sciences, Bornova, Izmir, TÜRKİYE
[2] Dokuz Eylul University, Mining Engineering Department, Buca, Izmir, TÜRKİYE
[3] Ege University, Department of Physics, Bornova, Izmir, TÜRKİYE
[4] Yoho Engineering Services, Llc, Karşıyaka, Izmir, TÜRKİYE

Coal-fired power plants are widely used worldwide in order to generate electricity. Coal, residues, and waste produced by combustion contain naturally occurring radionuclides such as $^{238}$U, $^{226}$Ra, $^{232}$Th, and $^{40}$K and trace elements such as Cd, Cr, Pb, Ni, and Zn. These radionuclides and trace elements become enriched in ash fractions during combustion. During high-temperature processes in the furnace, volatile and semi-volatile elements and radionuclides are partially emitted to the environment, resulting in the redistribution of these elements, especially in the surface soil around coal-fired power plants. Metal pollution, which is one of the most important environmental problems for many parts of the world, can enter the food chain, affect the entire ecosystem and pose a risk for human health. The focus of this study is therefore on the determination of the natural radionuclides and trace elements in soil samples which are collected by the grid method depending on the topographic variability. Trace elements concentrations and natural radionuclides were determined via inductively coupled plasma (ICP-MS) and gamma spectrometry, respectively. The ranges of the activity concentrations were between ND - 134±7 Bq/kg for $^{238}$U, ND - 89±5 Bq/kg for $^{232}$Th, 33±18 - 529±24 Bq/kg for $^{40}$K. Natural radioactivity and terrestrial dose distribution maps of the study area were created by geostatistical methods, ArcGIS 10.7.1 software ArcGIS Geostatistical Analyst module ordinary kriging method. While high levels were observed at $^{238}$U and $^{232}$Th concentrations in the south of the power plant, lower levels were observed in the east side. This may be due to the topographic structure of the land area and the prevailing wind direction. Bubble maps were created to show spatial trace elements concentrations with ESRI ArcGIS 10.7.1 software for Windows. While the Cu, Zn, Ni, and Pb concentrations obtained in the soil samples were around the earth crust abundance ratios, an enrichment was detected in the Hg and As concentrations.

**Acknowledgments:** This work was supported by grants from The Scientific Research Committee of Ege University, Contract No:FGA-2020-21865.

**Keywords:** Natural radionuclides, Trace elements, Soil contamination

## O-51 Preliminary Analysis of the INRNE-BAS Cyclotron Shielding

**A. Demerdjiev**[1], D. Tonev [1], N. Goutev[1], Dobromir T. Dimitrov[1], G. D. Dimitrova[1], E. Geleva-Dimitrova[1]
[1]Institute for Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences, 72, Tsarigradsko Chaussee Blvd., Sofia 1784-BULGARIA

The National Cyclotron Centre at the Institute for Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences (INRNE-BAS) is a new facility dedicated for production of medical radioisotopes. The primary goal of the project is the production of PET and SPECT isotopes as $^{18}$F, $^{67,68}$Ga, $^{99m}$Tc, etc. The laboratory will use a TR24 type of cyclotron, which generates proton beam with an energy of 15 to 24 MeV and current of up to 0.4 mA. This is a medium energy cyclotron and an intense secondary radiation (neutrons and gamma-rays) is generated during target irradiation. The typical shielding is a bunker with thick concrete walls. At the current project stage the shielding design has to be validated and optimized to meet the occupancy and dosimetry requirements. Also, it should be considered that during the cyclotron operational life the bunker concrete walls are activated by the secondary neutrons. As a result in the dismantling process of the facility a considerable amount of low level radioactive waste has to be disposed and characterized. In this work are presented results from the performed shielding analysis of the facility. For the purpose simulations were performed with the Monte Carlo particle transport code FLUKA. In this study different types of concrete and maze configurations of the bunker were considered. For these we made an evaluation of the distribution of the radiation fields (inside and outside the bunker) and the activation of the bunker walls. On basis of the results we made an assessment of the shielding design and some propositions for its optimization. Acknowledgments This research has been supported by the National Roadmap for Research Infrastructure 2020-2027 for the National Cyclotron Centre funded by the Bulgarian Ministry of Education and Science.

**Keywords:** TR24 Cyclotron, Monte Carlo Ssmulations, FLUKA, Radioactivity, Shielding

## O-52 Adsorption of Lead Isotopes from Aqueous Solutions using Clay Minerals

Osman Uygun[1], Rufiyet Guven[1], **Gaye Ozgur Cakal**[1]
[1]Ankara University, Institute of Nuclear Sciences, Ankara-TÜRKİYE

Lead, one of the highly toxic heavy metals, is a pollutant that may accumulate in living organisms through inhalation, ingestion, or skin penetration. Exposure to lead can damage the brain, kidney, liver, and reproductive organs. In addition to stable isotope ingestion, $^{210}$Pb radioactive isotope causes serious problems such as stochastic effects due to radiation exposure. According to WHO, the guideline is 0.1mg/L for stable lead isotopes and 0.1Bq/L for radioactivity originating from $^{210}$Pb in drinking water. Reducing the lead level in the water to its guideline is of critical importance. In addition to various methods, such as precipitation, ion exchange, solvent extraction, and reverse osmosis, adsorption is a practical and economical wastewater treatment process. To achieve an efficient adsorption process, the selection of the adsorbent and adsorption conditions plays a vital role. Clay minerals are preferably used for adsorption applications due to their high abundance and low cost. In this study, bentonite, sepiolite, and clinoptilolite were used as adsorbents and the remediation of $Pb^{2+}$ ions and $^{210}$Pb isotopes from aqueous solutions with the use of these adsorbents were examined under different experimental conditions. $Pb^{2+}$ ion amounts and $^{210}$Pb activities in the solutions were found by Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-OES) and Liquid Scintillation Counter (LSC), respectively, after each batch adsorption experiment. As a result of the experiments, the adsorption capacities were determined as 75.87mg/g, 42.51mg/g, 33.76mg/g, and the corresponding removal percentages were 94.84%, 53.14%, 42.20%, for bentonite, sepiolite, and zeolite, respectively, at the optimum conditions, which were pH 7, contact time 2 hours, solid/liquid ratio 5g/L, temperature 25°C, and shaking speed 75rpm at the initial $Pb^{2+}$ concentration of 400mg/L. In addition, the maximum adsorption capacities of bentonite, sepiolite, and zeolite were found as 130.38mg/g, 60.37mg/g, and 36.03mg/g, respectively. The results showed that the adsorption occurred both with cation exchange and electrostatic interactions. Moreover, similar removal percentages were obtained for $Pb^{2+}$ ions (with ICP-OES) and $^{210}$Pb isotopes (with LSC), as expected. As a conclusion, it was found that these minerals, especially bentonite, can effectively be used to remove lead from aqueous solutions.

**Keywords:** Adsorption, Leadi, LSC, ICP-OES, Remediation, Clay minerals

## O-53 Adsorption of Strontium and Cesium from Aqueous Solutions using Natural, Synthetic And Modified Zeolites

**Aysenur Murat**[1], Gaye Ozgur Cakal[1]
[1]Ankara University Institute of Nuclear Sciences, Ankara-TÜRKİYE

Radioactive dust created by nuclear or radioactive fallout is directly sent to the atmosphere, which is highly dangerous, particularly in terms of the fission products such as radioactive cesium ($^{137}Cs$) and strontium ($^{90}Sr$). Adsorption is one of the widely used treatment processes for the remediation of the environment due to its application easiness and cost. In this process, the selection of adsorbents and the adsorption conditions is critical for the removal efficiency of the radionuclides. Zeolites, which have high radiological stability and selectivity have many advantages for being used as adsorbents for the treatment of these radionuclides. In this study, the effects of experimental conditions on the adsorption of $Sr^{2+}$ and $Cs^{+}$ ions from the aqueous solutions were investigated by using different zeolites, namely clinoptilolite (natural zeolite mineral, CL), zeolite 4A (synthesized zeolite, Z4A) and surface modified clinoptilolite via iron incorporation (MCL). The effects of temperature, pH, adsorbent dosage, ion concentration, and time on the Sr and Cs adsorption capacity and the removal percentages of zeolite adsorbents were investigated in the batch adsorption experiments. As a result of the adsorption experiments, and a careful inspection of the adsorption capacities of the zeolite samples together with the removal percentages of Sr and Cs, the optimum adsorption conditions at the initial ion concentration of 200 ppm and a constant shaking rate of 75 rpm were determined as pH 8, contact time 2 h, adsorbent dosage 5g/L, temperature 25°C. The adsorption capacities of CL, MCL, Z4A, were found as 25.2 mg/g, 28.3 mg/g, 33.8 mg/g for Sr and 36.0 mg/g, 31.0 mg/g, 37.2 mg/g for Cs, respectively. The corresponding removal percentages were 63.0%, 70.8%, 84.4% for Sr and 90.0%, 77.4%, 93.0% for Cs, respectively. The results also showed that the adsorption occurred both with cation exchange and electrostatic interactions. To conclude, all the adsorbents used in this study were suitable to be used for the remediation of Sr and Cs from aqueous solutions, Z4A having the highest adsorption capacity. It should also be noted that modification of natural zeolite increased the adsorption capacity and this zeolite can easily be removed by using a permanent

**Keywords:** Adsorption, Zeolite, Strontium, Cesium, Remediation

## O-54 An Investigation of Radiation Shielding Performance of Glass Ceramics for Different Applications

**Sema Erentürk**[1], Ülgenay Tan[1], Abdullah Okyar[1], Berkay Camgöz[2], Sabriye Yuşan[2], Senem Şentürk Lüle[1]
[1]Istanbul Technical University, Energy Institute, TÜRKİYE
[2]Ege University, Institute of Nuclear Sciences, Bornova, Izmir, TÜRKİYE

Gamma-ray is ionizing radiation with extremely short wavelengths and, depending on its energy, penetrates matter. Gamma radiation with high-energy photons can harm those directly exposed to it, and long exposure times are particularly dangerous. Therefore, concrete and lead are widely used as radiation shielding materials due to their effective shielding properties, cheap cost, high density, high mass attenuation, and low maintenance. However, recently, they cannot meet the expectations for some nuclear technology applications due to their disadvantages such as poor mechanical properties, low chemical resistance, toxicity, and health hazards. The possibility of using natural rocks and minerals for radiation shielding materials is being explored because of their low cost and abundance. In recent years, many new materials such as metals and alloys, composites, glasses, polymers, ceramics, and glass-ceramics have been produced as shielding materials. Their performance against ionizing radiation has been tested. Glass ceramics are preferred in shielding applications against ionizing radiation due to their high thermal endurance, mechanical strength, corrosion resistance, and low density. This study is aimed to produce a lead-free, low-density, multifunctional glass-ceramic shielding material that provides the required gamma-ray shielding performances by using feldspar and some metal oxides, which are abundant in our country and in the world. In this framework, glass-ceramic shielding materials of different thicknesses and compositions were prepared. Structural characterization of the prepared glass ceramics was performed and their porosities were determined. The effective porosities of the prepared glass ceramics ranged from 0.001 to 0.074. Their densities are between 0.46-22.57 depending on their structural content. For gamma-ray ($^{137}$Cs) energies, gamma-ray linear and mass attenuation coefficients, half value thicknesses, and one-tenth value thicknesses were investigated. The values of the mass attenuation coefficients of the glass ceramic shielding materials at 661.7 keV vary between 0.232 and 11.90 $cm^2$ $g^{-1}$. On the other hand, the linear attenuation coefficients vary between 4.059 and 5.577 $cm^{-1}$. It can be considered that HLV of approximately 0.12-0.17 cm for the ceramic shielding materials depending on the structural content could attenuate the photons with energies at 661.7 keV. TVL of the glass ceramic shielding materials were found between 0.03-1.50 at 661.7

**Keywords:** Gamma shielding, Glass ceramics, Attenuation coefficient, HLV, TVL

## O-55 Nuclear Safety and Security Culture Development in Newcomers

**Bahire Gül Göktepe**[1]
[1]NUTEK Energy, Industry, Trade and Consulting Inc., Istanbul, TÜRKİYE

Nuclear safety is a dynamic field. The nuclear power industry has been continuing to improve the safety and the performance of operating reactors. However, since the Fukushima event, nuclear safety and safety culture as well as safety leadership have become one of the highest priority issues around the world. Although a safety culture development program is necessary for all nuclear countries and companies, it is especially critical for newcomers starting from the pre-operational phase. Safety Culture Aspects in Newcomers When a country embarking on a Nuclear Power Program, there are many aspects to consider. Building a national nuclear power infrastructure as one of the priorities is a complex issue, requiring several years of planning. Implementation of nuclear safety infrastructure includes various steps. Major progressive steps for ensuring nuclear safety requires the availability of suitably qualified staff and the establishment of an effective safety culture in the country of concern. However building safety and security culture in newcomers is a complex process. It is a challenge! Major questions and debates are mainly on; how to build safety culture? How to assess factors influencing safety culture? How to implement program by utilizing lessons learnt from the experience of nuclear industry in the nuclear power countries and nuclear accidents. What is the best practice for creating a strong, positive, reliable, manageable, sustainable safety culture? NUSAC and NUSEC programmes, designed developed based on this logical approach will be presented briefly.

**Keywords:** Nuclear safety, Security, Human factors

## O-56 Antimicrobial Photodynamic Therapy using Icg Loaded Fdg Conjugated Superparamagnetic Iron Oxide ($Fe_3O_4$) Nanoparticles

**Önder Bakır**[1], Kadriye Buşra Karatay [1], Elif Tutun[1], Volkan Yasakçı[1], Gillian Pearce[2], Perihan Unak[1]
[1]Ege University, Institute of Nuclear Sciences Bornova, Izmir-TÜRKİYE
[2]School of Engineering and Applied Sciences, Aston University, Birmingham, West Midlands-UK

Superparamagnetic iron oxide nanoparticles (SPIONs) have been recently recognized as highly efficient photodynamic therapy (PDT) agents. Here, we demonstrate, combined therapy of radiotherapy (RT) and dependent PDT potential of ICG loaded FDG conjugated $Fe_3O_4$ nanoparticles (ICG@FDGMNPs). Indocyanine green (ICG) which has a potential for PDT, was inserted to ICG@ FDGMNPs and to get an effective combined therapy with RT and PDT on E.coli (Escherichia coli) bacteria via a LED beam and LINAC X-ray source treatment. The potential of the ICG-loaded FDG MNPs for PDT and radiotherapy was evaluated by using 4 different study groups which underwent different combinations of both treatment methods. The 1st group was exposed to light (400–700 nm wavelength and 5.1 ($Jcm^{-2}$) powers LED light source for 5 min at 30 cm) first then after 24 h was exposed to radiation (X-ray beam with an energy of 6 kV for 2 minutes at a dose of 500 mSv per minute at 100 cm). The 2nd group was exposed to radiation first and then the LED beam source. The 3rd group was only exposed to an LED beam source and the 4th group was only exposed to radiation. According to the results of photodynamic therapy/radiotherapy studies, it was observed that when the nanoconjugate was first stimulated with light on E.coli and Green Fluorescence Protein-E.coli bacteria, radiation damage increased and bacterial death occurred accordingly. In the control group, bacterial damage decreases with increasing concentration. It was observed that the vitality rate for the 1st and 2nd groups, in which light and radiation were applied at the same time, were lower than the 3rd and 4th groups, where only light or only radiation was applied. At the same time, FDG-MNP conjugated with ICG was found to be more effective especially in GFP-E.coli bacterial strains. It was observed that the bactericidal effect of FDG-MNP and ICG-FDG-MNP was higher than the control groups. This can be explained as nanoconjugates on bacteria, light-excited nanoconjugates increase radiation damage and bacterial death increases as a result of increased damage.

**Keywords:** Photodynamic therapy, LINAC, Superparamagnetic iron oxide nanoparticles, Indocyanine green (ICG), Near- Infrared (NIR), E.coli, Green fluorescence protein

## O-57 $^{99m}$Tc[Tc]-DPAPA-Conjugated Cubic $Fe_3O_4$ Nanoparticles: Synthesis, Radiolabeling and In Vitro Affinities on Prostate Cancer Cells

Volkan Yasakçı[1], **Elif Tutun**[1], Kadriye Buşra Karatay[1], Ömer Aras[2], Perihan Ünak[1]
[1]Ege University, Institute of Nuclear Sciences, Bornova, Izmir-TÜRKİYE
[2]Memorial Sloan Kettering Cancer Center, Department of Radiology New York, Ny 10065-USA

The aim of this work is to create a theranostic nanoprobe for magnetic hyperthermia (through the cubic $Fe_3O_4$ NPs) as well as hybrid imaging with SPECT/MRI. For this purpose, an ethylenediamine tetra (methylene phosphonic acid) (EDTMP) derivative called (S)-2,5-bis(bis(phosphonomethyl)amino) pentanoic acid (DPAPA) conjugated $Fe_3O_4$ NPs was synthesized and in vitro affinities were studied on prostate cancer cells. Methodology: $Fe_3O_4$ nanocubes were synthesized, coated with silica and HPG (hyperbranched polyglycerol). DPAPA was synthesized using Mannich-type reaction and then conjugated with $Fe_3O_4$ NPs. The nanocomposites were characterized with SEM, TEM, DLS, FTIR, NMR, HPLC and VSM. Then, nanoconjugates were labeled with 99mTc and determined labeling yield with TLC and HPLC. Cytotoxicity, apoptosis studies were assessed on prostate cancer cell lines. Results: The NPs are about 50 nm in size and cubic shaped. The labeling yield of C-$Fe_3O_4$-$SiO_2$-HPG-$NH_2$-DPAPA-$^{99m}$Tc was 85% and each labeled nanoconjugate was stable at least for 24 h at room temperature. Prostate cancer cell affinities, cytotoxicity and apoptosis values were determined using in vitro cell culture assays. Cell affinities and apoptosis ratios were highest for LnCaP cells comparing to nontarget cell lines. DPAPA-conjugated HPG-coated C-$Fe_3O_4$ nanoconjugates have a high affinity to human prostate cancer cells and are theranostics with their imaging and therapy potentials. [$^{99m}$Tc]Tc-DPAPA-C-$Fe_3O_4$ NPs could be used as a human prostate cancer imaging agent with their SPECT imaging and therapy potential with magnetic hyperthermia.

**Acknowledgment:** This study was financially supported by TUBITAK Project number 218S749. Volkan Yasakçı was supported with 100/2000 CoHE Doctorate Scholarship. The authors would like to thank TUBITAK and 100/2000 CoHE PhD for their support.

**Keywords:** Cubic Iron Oxide Nanoparticles, Hyperbranched Polyglycerol, 3,5-bis(diphosphoamino)pentanoic Acid, Technetium-99m, Prostate Cancer Cells

# POSTER ABSTRACTS

## P-1 Microbiological Studies Under Gmp Requirements at a Radiopharmaceuticals Production Facility, TENMAK

**Büşra Opçin**[1], Elif Kütük[1], Selcan Siyakuş[1]
[1]Turkish Energy Nuclear and Mineral Research Agency, Proton Accelerator Facility, Kahramankazan/Ankara-TÜRKİYE

TENMAK Proton Accelerator Facility produces radiopharmaceuticals under Good Manufacturing Practices (GMP) regulations and these radiopharmaceuticals are being administered to the patients in different hospitals (public and private) both in Ankara and Istanbul, since 2020. The radiopharmaceuticals which are being produced at TENMAK Proton Accelerator Facility are intravenously (I.V) injectable sterile medicinal products, thus the production area needs to meet several specific requirements. Classification of the production area with respect to some physical and microbiological parameters and the sustainability of these conditions during not only production but also rest of the time can be stated at first. Also, as I.V solutions, radiopharmaceuticals should be tested for sterility and bacterial endotoxins and bioburden levels of them prior to sterilisation should be determined. All of the microbiogically confirming of the conditions and microbiological tests are being performed at the microbiological quality control laboratories of TENMAK Proton Accelerator Facility via the validated test methods and equipments according to the European Pharmacopeia (EP) and ISO 14644 standards by qualified biologists. At this poster, establishment of the microbiological environmental monitoring system at TENMAK Proton Accelerator Facility and microbiological testing of the finished products are presented in the trend tables. In addition, it is aimed to gather together the studies carried out at TENMAK Proton Accelerator Facility on this subject under GMP requirements.

**Keywords:** Good manufacturing practice, Environmental microbiological monitoring, Radiopharmaceuticals, Microbiological quality control tests.

## P-2 The Quality Control of Thallium Chloride Tl-201 (37 MBq/ml) Produced at TENMAK Proton Accelerator Facility

**Selçuk Gürgür**[1], Hasan Kütük[1], Aynil Çetin[1]
[1]Turkish Energy Nuclear and Mineral Research Agency Proton Accelerator Facility, Kahramankazan/Ankara-TÜRKİYE

Thallium Chloride Tl-201 ($^{201}$Tl-TlCl) is a radiodiagnostic single photon emission computed tomography (SPECT) agent used for nuclear medicine especially for myocardial viability. It is a licenced radiopharmaceutical product manufactured at TENMAK Proton Accelerator Facility and being marketed since 2020. Quality control (QC) tests of this radiopharmaceutical are divided into 6 groups as; (1) identification test, (2) radionuclidic purity test, (3) radiochemical purity test, (4) chemical purity test, (5) physicochemical and physical tests and (6) microbiological tests. All these tests are performed at the QC laboratories at TENMAK Proton Accelerator Facility, via the validated and verified test methods and equipments according to European Pharmacopeia EU GMP by qualified personnel (chemists, engineers and biologists). In this study, the quality control test methods will be explained and the results will be shown in trend tables and figures.

**Keywords:** Quality Control, $^{201}$Tl-TlCl, TENMAK Proton accelerator facility, Good manufacturing practice, European Pharmacopoeia, Radiochemical purity, Radionuclidic purity, Quality control tests

## P-3 Superparamagnetic Iron Oxide Nanoparticles (Spions) Coated with $^{198}$Au For Nanobrachytherapy of Hepatocellular Carcinoma (HCC)

Nasrin Abbası Gharıbkandı[1], Michal Zuk[2], Kinga Żelechowska Matysıak[1], Kamil Wawrowıcz[1], **Fazilet Zumrut Bıber Muftuler**[3], Aleksander Bılewıcz[1]
[1]Instutute of Nuclear Chemistry and Technology, Warsaw-POLAND
[2]Warsaw University, Faculty of Chemistry, Warsaw-POLAND
[3]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

Hepatocellular carcinoma is a rapid-growing tumor with poor prognosis, and the majority of HCC tumors are unresectable at diagnosis. Standard systemic chemotherapy is poorly tolerated and does not prolong survival, and the same poor results are seen with hormonal therapy. Recently, there has been a dynamic development of many local targeted therapies, such as ablation and internal radiotherapy through intra-arterial administration of Yttrium-90 ($^{90}$Y) and Iodine-125 ($^{125}$I) microspheres or injection into a colloidal Phosphorus-32 ($^{32}$P) tumor. These localized techniques achieve partial tumor destruction, but relapses are common. Recently, in the published paper [1] authors proposed application of gold nanoparticles as a photosensitizer and an external radiation source. It is known that a $\beta^-$ - emitter Gold-198 ($^{198}$Au) could be used in radionuclide therapy of small tumors or tumor metastasis. On the other hand, superparamagnetic iron oxide nanoparticles (SPIONs) are already widely used in magnetic hyperthermia. Therefore in our work, we propose combining internal radiotherapy with magnetic hyperthermia through the injection directly into the tumor magnetic radioactive nanoparticles. For this purpose, SPIONs were synthesized, coated with $^{198}$Au layer and conjugated with polyethylene glycol (PEG). Synthesized SPIONs-$^{198}$Au-PEG have hydrodynamic diameter of 99.39 ± 0.22 nm and was stable in biological fluids. It also showed magnetic properties. For evaluation of its in-vitro behavior, cytotoxicity studies using of liver cancer cell line (HepG2) were performed by MTS assay. We observed high cytotoxicity for doses in the range 1.25 - 20 MBq/mL SPIONs-$^{198}$Au-PEG already after 48 h. For the 20 MBq/mL dose there was a 27 % survival rate, while for the 1.25 MBq/mL dose there was a 54% survival rate. After 72 h the toxicity was much higher, for the lowest dose 12 % metabolic activity was reached. As a conclusion, the current in vitro cell culture experiments showed a very high cytotoxicity of the SPIONs-$^{198}$Au-PEG radiobioconjugate, which, in combination with its magnetic properties, may allow its use in internal radiotherapy combined with magnetic hyperthermia. Of course further in vivo investigations using animal models are needed.

1. G.Meili et al., Enhanced Radiation Therapy of Gold Nanoparticles in Liver Cancer. Appl. Sci. 7 2017.

**Keywords:** Superparamagnetic iron oxide nanoparticles (SPIONs), Gold-198 ($^{198}$Au), HepG2 cell lines.

## P-4 Green Synthesis of Magnetite and Evaluation of Their Use in Magnetic Particle Testing

**Melise Karatay Kutman**[1], Ozge Kozgus Guldu[1], F. Zumrut Bıber Muftuler[1], Coskun Harmansah[2]
[1]Institute Of Nuclear Sciences, Ege University, Izmir-TÜRKİYE
[2]Ege Vocational School, Ege University, Izmir-TÜRKİYE

Non-destructive testing (NDT) is used to control the production process of materials, to ensure the quality and reliability of the product to perform a standard maintenance procedure that plays an important role in aviation, automotive, rail industry, petrochemical and machinery industries. This study aimed at the application of magnetite ($Fe_3O_4$-NPs) obtained by green synthesis using green tea extracts (GTE), watermelon rind extracts (WRE) and banana peel extracts (BPE). The research results of the synthesis of magnetite using different green chemistry-based plants conjugation of fluorescent dye to the synthesis product and the usage potential as magnetic particle suspension in NDT are summarized. For this purpose, magnetite prepared by three different methods by green synthesis using GTE, WRE and BPE separately were analyzed with DLS, SEM and EDS. According to DLS measurements, hydrodynamic dimensions of GTE@$Fe_3O_4$, WRE@$Fe_3O_4$ and BPE@$Fe_3O_4$ nanoparticles were determined as 717.5, 554.8 and 2020 nm respectively. When the SEM images were examined, the sizes of GTE@$Fe_3O_4$, WRE@$Fe_3O_4$ and BPE@$Fe_3O_4$ nanoparticles were found in the range of 71-101, 50-75 and 80-117 nm. According to EDS measurements, atomic percentages of iron (Fe) and oxygen (O) elements in the content of GTE@$Fe_3O_4$ nanoparticles were 8.89, 51.73, and in the content of WRE@$Fe_3O_4$ nanoparticles were 17.28, 31.97 and in the content of BPE@$Fe_3O_4$ nanoparticles were found to be 12.88 and 9.92 respectively. When the VSM results were examined, the hysteresis curves showed that the saturation magnetism value (Ms) for GTE@$Fe_3O_4$ nanoparticles were 1.76 emu/g, for WRE@$Fe_3O_4$ nanoparticles Ms 24.35 emu/g, for BPE@$Fe_3O_4$ nanoparticles Ms 23.45 emu/g, and Ms for commercial magnetic powder was 43.64 emu/g. After the determination of the structural properties of the NPs were completed, fluorescent isothiocyanate was conjugated to NPs in order to give fluorescent properties. The magnetic suspensions that could be used in magnetic particle testing (MT) were obtained and under 1000A AC current with the Magnaflux MAG20 device were applied to the reference test block. Thus, the discontinuity at six locations at different depths on the reference test block was detected. As a result, the widespread use of green chemistry in industrial applications reveals new approaches in NDT.

**Keywords:** Green chemistry, Non-destructive testing (NDT), Magnetite, Nanoparticles, Magnetic particle testing (MT)

## P-5 In Vitro Wound Healing Potential of Hyaluronic Acid Loaded Silver Nanoparticles in Human Gingival Fibroblast

**Zarrın Salajı**[1], Özge Kozguş Güldü[2], Banu Özveri Koyuncu[3], Sema Çınar Becerik[4], Emin İlker Medine[2]

[1]Department of Biotechnology, Graduate School of Natural and Applied Sciences, Ege University, Izmir-TÜRKİYE

[2]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

[3]Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Ege University, Izmir-TÜRKİYE

[4]Department of Periodontology, Faculty of Dentistry, Ege University, Izmir-TÜRKİYE

Due to the long-term use of bisphosphonates in patients undergoing cancer treatment, osteonecrosis of the jawbone and wound formation on the gums are observed. Various mouthwashes are routinely used in the treatment of these wounds. However, this type of mouthwash quickly moves away from the wound area with saliva in the mouth. Therefore, since the mouthwashes used cannot show their effectiveness in the wound area for a long time, their wound healing potential remains very low. In the following process, deep mouth sores occur with the effect of bacteria in the mouth and external contamination. This causes the patient to suffer and reduce their quality of life. In this study, in order to develop a product with higher wound healing potential, in vitro wound healing potential of the obtained conjugate on human gingival fibroblasts was determined by conjugating hyaluronic acid, which has cell proliferation-enhancing properties, and silver nanoparticles with antibacterial properties.

**Keywords:** Silver, Hyaluronic acid, Nanoparticle, Cancer drugs, Gingival fibroblasts, Osteonecrosis of the jaw

## P-6 Natural Terrestrial Radiation Levels and Dose Contributions of Cultural and Historical Settlements in East Anatolia

Berkay Camgöz[1], **Nurdan Akakçe**[1,2]
[1]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE
[2]Ege University, Central Research Test and Analysis Laboratory Application and Research Center, Izmir-TÜRKİYE

Terrestrial radioactivity is a major component of environmental radioactivity. It is mostly sourced from the geological structure of the earth's crust; the structure includes natural radionuclide series (Uranium, Potassium, and Thorium) since the occurrence of our planet. Peoples get radiation dose naturally that originated from mobilized terrestrial radionuclides annually around 2.4 mSv as world mean. Although the dose is a mean value in a bandwidth it varies in local placements because of different geological properties and man-made facilities which affect the mobility of radionuclides toward the people. The dose must be measured locally. Especially crowded life areas and visited zones are important as radiometric characteristics. Anatolia is over all touristic country on a large historical scale, it has ranged from prehistoric to today. The number of annual touristic visitors is very dense in Anatolian settlements. Cultural and history scale diversity is heterogeneous between east and west. This study is subject to independent touristic places in eastern Anatolia as a pattern. In this pattern, several places were selected in the common route of touristic travels in east Anatolia. St. Pier Church, Harbiye Waterflow, the Kommagene Kingdom in Nemrut Mount, Hasankeyf, Kasımiye Medressah, Darülzeferan Monastery, relics of old Harran University, Göbeklitepe, and Halfeti are destinations on the route in this study. Radiation concentrations of samples that were collected from the destinations were measured by a gamma spectroscopic system and dose contributions were calculated to associate with cancer risk. Radon activity concentrations were measured in 21-154 $Bq/m^3$ intervals, U-238, Th-232, and K-40 activity concentrations were obtained between 2.4 and 554 Bq/kg as a range. This data does not exceed officially determining risk limits but calculated dose contributions should be known for deviation amounts around the world mean.

**Keywords:** Terrestrial radioactivity, Radiation dose, Radiation risks

## P-7 Radiolabeling of Nanoparticles with Long Lived Radiometals for PET Imaging

**Ezgi Gül Bağcı**[1]
[1]Turkish Energy, Nuclear and Mineral Research Agency, TENMAK, Ankara-TÜRKİYE

Radiolabeling of Nanoparticles with Long Lived Radiometals for PET Imaging Important radio tracer studies used in early diagnosis of cancer with Positron Emission Tomography (PET) molecular imaging technique have been the subject of research today. Developing imaging diagnostic agents that can detect early pathological changes will support the control of disease at the beginning stages. Several isotopes have been used in positron emission tomography such as $^{18}F$, $^{89}Zr$, and $^{68}Ga$ for early treatment monitoring. PET which has tremendous advances in bioimaging techniques provides effective monitoring for cancer diseases by using radio tracers. With the increasing development of advanced therapeutic medicinal products (ATMPs) such as monoclonal antibodies, nanoparticles and cellular therapies, there is a need to develop new agents with the ability to image over longer timescales than the small drug like molecules traditionally used for PET imaging to enable the tracking and monitoring of ATMPs in vivo. To obtain good monitoring of treatment depends on radionuclide features such as half-life. As a result, increased in exploring the utilization of longer half-life tracers that are suitable for bioimaging such as new tracers based on the $^{89}Zr$ -labeled (half-life: 78.4 h). In this study examined the particle size of superparamagnetic iron oxide nanoparticles, label stability of radiolabeled nanoparticles with $^{89}Zr$, and suitability of sucrose gradient for separation. End of this study, we obtained that the nanoparticles could be labeled with Zr-89, synthesized in different sizes, however, more experimental studies are needed for its use as a clinical actual imaging technique agent and for reproducible and reliable results. To sum up, it can be accepted from promising studies because it will be very effective results in increasing the image quality and decreasing the dose to be applied to the patient. This study received all support from the, Republic of Turkey, Ministry of National Education and Nuclear Energy Research Institute. Also, all these experiments supported by PETIC crew in Cardiff University via Dr. Stephen PAISEY.

**Keywords:** PET, long-lived radioisotopes, Zr-89, Superparamagnetic iron nanoparticles

## P-8 Electrical Conductivity in Gamma-Irradiated of Tlga1-Xinxse2(1-X)S2X Solid Solution

**Famin Salmanov**[1]
[1]Institute of Radiation Problems, Azerbaijan National Academy of Sciences-AZERBAIJAN

Depending on the temperature dependence of the electrical conductivity of samples exposed to radiation at doses of 0, 0.25 and 0.75 MGy at temperatures above room temperature, it was found that the value of conductivity increased several times at a certain critical temperature. Such a characteristic increase in conductivity indicates that ionic conductivity predominates at temperatures above that critical temperature. One of the facts showing the existence of ionic conductivity is that in the temperature-dependence curve of electrical conductivity, the linear regularity of the 1/T dependence of ln(σ·T) in the temperature range in which ionic conductivity exists. Based on the experimental values, it was found that the dependence of ln(σ·T) on (1/T), which is characteristic for ionic conductivity in the studied solid solutions, is subject to linear regularity. At temperatures above room temperature, the dramatic change in electrical conductivity observed in solid solutions of the TlGa1-xInxSe2(1-x)S2x (x=0,6; 0,7; 0,8; 0,9; 1,0) system can be explained by a sharp increase in the number of highly mobile Tl ions, which creates a phase transition to the superion state. This change occurs as a result of the phase transition of solid solutions of the TlGa1-xInxSe2(1-x)S2x (0; 0,1; 0,2; 0,3; 0,4; 0,6; 0,7; 0,8; 0,9; 1,0) system, accompanied by irregularity of the Tl sublattice (melting of the sublattice). Such conductivity is typical for superion conductors. As is known from the literature, along with the exponential increase in electrical conductivity with increasing temperature in substances with superionic conductivity, an exponential increase in dielectric constant is also observed, and at high temperatures its value is many times greater than its value in the low temperature region. Such behavior of the ε(T) dependence in solid solution samples is most likely due to the movement of ions on the defects. Thus, the high value of the dielectric permittivity of TlGa1-xInxSe2(1-x)S2x(0; 0,1; 0,2; 0,3; 0,4; 0,6; 0,7; 0,8; 0,9; 1,0) solid solutions at low frequencies is based on the mechanism of ionic polarization caused by weakly bound thallium ions.

**Keywords:** Gamma irradiation, Electrical conductivity, Solid solutions, Ionic polarization, Superion state

## P-9 Influence of Radiation on Turkish Lignites

Nijat Bagirli[1], **Fethullah Cicek**[2], Gulay Bulut[1], Islam Mustafayev[2]
[1]Istanbul Technical University, Istanbul-TÜRKİYE
2 Institute of Radiation Problems, Azerbaijan National Academy of Sciences, AZERBAIJAN

The effect of gamma radiation on Soma and Ankara-Cayirhan lignites of Turkey was studied. The experimental results were compared with the results obtained in the previously studied Karaman-Ermenek, Nevsheher, Silopi, Trakya lignites [1]. The kinetics of generation of $H_2$, $CH_4$ gases under the influence of gamma radiation was studied in the range of dose D=0-23.7 kGy. The radiation-chemical yield of gases is equal to $G(H_2)$= 0.041, $G(CH_4)$= 0.007 molec/100 eV in Soma lignites and to $G(H_2)$=0.030 $G(CH_4)$= 0.006 molec/100 eV in Cayirhan lignites. For comparison, let's note that these values are equal to G(H2)= 0.024, $G(CH_4)$= 0.0007 in Karaman-Ermenek lignites, $G(H_2)$ = 0.024, $G(CH_4)$ = 0.005 in Nevseher lignites, $G(H_2)$= 0.062, $G(CH_4)$= 0.021 in Silopi lignites, $G(H_2)$ = 0.019, $G(CH_4)$ = 0.001 in Trakya lignites. Obtaining different values for the yields of gases in these lignites is due to the difference in their composition and structure. Differential-thermal and Electron-spin resonance studies were also conducted on these lignites. It has been shown that the influence of gamma rays in the indicated dose range leads to destructive effects, which is manifested in the increase in the speed of their thermal decomposition. A singlet signal with g=2.0023, $\Delta H$=40÷50E was observed in the ESR spectrum of lignites. The concentration of paramagnetic centers in lignites is 1019 spins/g. The kinetics of change of the intensity of this signal depending on the absorbed dose was studied. The report discusses in detail the role of their structure and composition in radiation-chemical transformations of lignites.

1. I. Mustafayev, F. Chicek, E. Yuzbashov. Gas formation regularities at the consecutive and simultaneous impact of ionizing radiations and heat on Turkish lignites. Fuel, 2011, v. 90, p. 2555-2559. Springer.

**Keywords:** Turkish lignites, γ-radiation, Gases, DTA, ESR

## P-10 Evaluation of X-Ray Shielding Performance of Coated Textile Materials

**Fatma Yurt Onaran**[1], Elif Pınar Yozgatlı[1], Caner Taskopru[1]

[1]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

The use of technological devices such as mobile phones, televisions and wireless internet in daily life causes an increase in radiation exposure. There are three principles for protection from radiation. These are; time, distance and shielding. Shielding is the most effective method for radiation protection. Radiation shielding products containing lead are used to protect from radiation. Lead is the most commonly used material in shielding due to its high atomic number and density. The toxic, heavy and brittle nature of lead has led to the search for alternative shielding materials. In this study, aimed to develop coated textile materials have shielding properties against X-rays. Within the scope of the study, three different dispersion preparations containing 60% by weight of Barium Sulphate, Bismuth Oxide and Tungsten Oxide metal powders were made. Two knitted and two woven fabrics of different thickness and construction were used in the study. Each coating dispersion containing Tungsten Oxide, Barium Sulphate and Bismuth Oxide metal powders was applied to the fabrics as a separate layer. Prepared dispersions were applied to four different fabrics by knife coating method. The radiation attenuation ratio of the coated fabric samples was calculated as a percentage with the formula of Lambert-Beer. Radiation attenuation ratio values against X-rays at tube voltages of 40 kV, 60 kV, 80 kV, 120 kV; thickness changes and SEM images of the obtained coated fabrics were investigated. As a result of the study, an increase in thickness was observed in all of the coated fabrics, and a film layer was formed on the fabric surfaces. The coated fabrics that provide over 90% protection against X-rays were obtained.

Acknowledgments: This research was supported by the Ege University, Scientific Research Project (BAP), and Project Number: FYL-2020-22432

**Keywords:** X-ray shielding, Coated fabrics, Barium, Bismuth, Tungsten

## P-11 Recent Developments On The Cylindrical Inertial Electrostatic Confinement Fusion Device

**Betül Yasatekin**[1], Arife Seda Bölükdemir[1], İhsan Kılıç[1], Tolga Öncü[1], Yeşim Olgaç[1], Ali Alaçakır[2]

[1]Turkish Energy, Nuclear and Mineral Research Agency-Nuclear Energy Research Institute, Ankara-TÜRKİYE

Deuterium-deuterium (D-D) based nuclear fusion studies are carried out by designing and constructing small fusion devices at the Nuclear Energy Research Institute (NUKEN) of the Turkish Energy, Nuclear and Mineral Research Agency (TENMAK) in parallel with the developments in the world. In this context, a Cylindrical Inertial Electrostatic Confinement (C-IEC) device, the most recent fusion reactor where magnetic as well as electrostatic compression is utilized, designed and produced with local resources. The designed reactor has 11 ports reserved for cathode feedthrough, vacuum pump, vacuum gauge, Inductively Coupled Plasma (ICP) type deuterium ion sources and viewports. The C-IEC reactor was operated in the range of 70 – 95 kV negative DC voltage and 100 – 400 W RF power. While the maximum number of neutrons with the previously operated spherical reactor (named SANAEM-IEC in the literature) was obtained as $3.6\times10^5$ n/s, a value of $6\times10^7$ n/s has been reached with the C-IEC reactor. Through these studies, the laboratory infrastructure has been developed and hence, knowledge and experience has been improved for the future experimental fusion studies in our institution.

**Keywords:** D-D reactions, Fusion, neutron, Inertial electrostatic confinement, High voltage, Ion source

## P-12 Portable Gamma Dosemeter with Ceramic Scintillator

**Ali Akgöz**[1], Muhammet Barık[1]
[1]Turkish Energy, Nuclear and Mineral Research Agency, Ankara-TÜRKİYE

Passive and active portable dosemeters are widely used all around the world and in our country (Turkey). A new prototype active dosemeter device has been produced within TENMAK in which the dose data are obtained by new generation ceramic scintillators and can be recorded wirelessly via mobile devices or directly in an online database.

**Keywords:** Dosemeter, Gamma, Scintillator, Detector, Portable, Radiation, Prototype

## P-13 The Effect of Potassium Humate on Morphological and Physiological Parameters in Seedlings Obtained from Gamma Irradiated Seeds of Maize (Zea Mays)

Mahir Farajov[1], **Zohra Muslumova**[1]
[1]Institute of Radiation Problems, Azerbaijan National Academy of Sciences, AZERBAIJAN

Humic substances are widely used in agriculture as organic fertilizers. Various salts of humic acids are also used as growth and development stimulants. The stimulating effect of humic compounds on the growth and development of plants, increasing their resistance to adverse environmental factors has been sufficiently studied. Soluble forms of humates in small concentrations significantly stimulate the growth and development of plants, increase the supply of nutrients to plants, activate protein and carbohydrate metabolism, and increase crop yields. We studied the effects of potassium humate (PH) on growth and development, on the morphological and physiological parameters of maize (Zea mays) variety "Zacatala 68" under conditions of radiation stress. It is known that ionizing radiation ultimately causes a violation of the integrity of cellular structures. The radioprotective properties of potassium humate were studied under model field conditions. These experiments included a study of the growth dynamics of maize (Zea mays) seedlings obtained from irradiated corn seeds at doses of 50 and 100 Gy. Potassium humate was obtained from pine needle compost. We studied the percentage of humus in the compost and the elemental composition of the potassium humate. Before irradiation, maize seeds were treated with humate solutions at a concentration of 0.1% and 0.01% . The effect of potassium humate was studied both before and after γ-irradiation. We also studied the effect of potassium humate solutions on the amount of malonic dialdehyde, an indicator of lipid peroxidation, on chlorophyll pigments and carotenoids, and on the fluorescent indices of leaves (photosystem II) in seedlings. The amount of chlorophyll a (662 nm), chlorophyll b (644 nm), carotenoids (440 nm) pigments and malondialdehyde (532 nm) determined spectrophotometrically (Multiscan Go, Germany). The maximum fluorescence quantum yield of wheat seedlings was measured on a MINI-PAM fluorometer (Germany). The results obtained from the experiments performed indicate that the use of potassium humate solutions prevents damage to wheat seedlings grown from irradiated seeds, compared with seedlings obtained from irradiated samples not treated with potassium humate solutions. A positive effect of potassium humate solutions was also observed in the study of seed germination in irradiated maize samples. Irradiation of corn seeds at a dose of 100 Gy markedly inhibited the development of seedlings. A positive effect was also observed in experiments to study the effect of humate solutions on the dynamics of growth and development of plants. Seedlings obtained from seeds treated with a 0.01% solution of potassium humate showed the best results in all stages of development of growth and development throughout the entire development stage. Based on the results obtained, it can also be concluded that potassium humate solutions lead to a decrease in the level of lipid peroxidation products - malondialdehyde and the maintenance of a normal concentration of photosynthetic pigments. In plants treated with 0.01% potassium humate solution, corncobs appeared earlier than others and were larger. A 0.01% solution of potassium humate showed the highest radioprotective activity, reducing the harmful effects of gamma irradiation at a dose of 100 Gy. Thus, it can be said that the use of low doses of radiation and optimal concentrations of humate solutions and the creation of technologies on this basis makes it possible to grow agricultural plants under stressful conditions, and also increase plant productivity.

**Keywords: M**aize, Potassium humate, Chlorophyll pigments, Radioprtective activity, Lipid peroxidation.

## P-14 The Possible Application of Boron-Containing Polymers for Gamma-Ray Shielding

M. Agehan Yalcinkaya[1], F. Tuba Coğalmış[1], Sevilay Haciyakupoglu[1], **B. Filiz Senkal** [1]
[1]Istanbul Technical University, Istanbul-TÜRKİYE

Radiation has been employed in technology, natural science, and medical purposes. Ionizing radiation possesses sufficient energy to force an atom's electrons out and produce free radicals. Along with having an adverse impact on the environment, it may also cause significant harm to living things by destroying biological molecules and leading to cell mutation, organ damage, and other negative impacts. High penetrability radiation types like gamma rays and neutrons must be protected from. In this study, the attenuation characteristics of gamma rays were examined using boron nitride and a polymer of polyaniline combined in various ratios in formic acid medium. A scintillation spectroscopy system was used to measure the radiation intensities in order to calculate the gamma-ray attenuation properties for the gamma shielding qualities. The outcomes of the experiment were contrasted with those of the Geant 4 simulation program. In the experimental data, the linear absorption coefficients of the five distinct composites ranged from 0.119 cm-1 to 0.143 $cm^{-1}$, while in the Geant4 simulations, they ranged from 0.103 $cm^{-1}$ to 0.148 $cm^{-1}$. The results showed that the produced polymer composites reduced Cs-137 gamma rays with 662 keV energy between 29% and 42% when compared to lead standards of various thicknesses. Because of the drawbacks of lead, such as its toxicity, lack of flexibility, and limited chemical resistance, researchers are still looking for new materials. Polymer composites may be an alternative because of their light weight and shapeability as shielding materials.

**Keywords:** Shielding, Gamma-ray, Neutron, GEANT-4, Polymer

## P-15 Investigation of Nuclear Imaging and Photodynamic Therapy Potential of Phthalocyanines in Glioblastoma Cell

**Derya Özel**[1]
[1]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

In recent years, photodynamic therapy (PDT) has been used with high therapeutic success, which does not cause side effects in the patient. And PDT agents have been designed for the effective treatment of cancer. A new promising method for tumor response in real-time has recently been proposed to detect changes in uptake during treatment using radiolabelled PDT agents. This method consists of PDT applied during a dynamic SPECT/PET study. Thus, the effects of the treatment are observed in real-time based on the kinetics of the radiopharmaceutical. For this purpose, we investigated in vitro nuclear imaging potential and the phototherapy effects of cobalt- phthalocyanines carboxylic acid derivatives (Co-Pc), zinc-phthalocyanines carboxylic acid derivatives (Pc 1), and zinc phthalocyanine (ZnPc) in U87-MG human glioblastoma cell line. The synthesized Pcs were also radiolabelled with 7.4 MBq Iodine-131 ($^{131}$I) using the iodogen method. $^{131}$I-Co-Pc, $^{131}$I -Pc1, and $^{131}$I-ZnPc were investigated for their nuclear imaging potential as in vitro. For PDT studies, the cells were exposed to white light at 10–60 J/cm$^2$ in the presence of Pcs. The results showed that Pcs were a good PDT agent to be used in the U87 mg cell line. As a result, Pcs can be promising nuclear imaging and PDT agent for glioblastoma.

**Keywords:** $^{131}$I, Nuclear Imaging, Photodynamic therapy, Glioblastoma

## P-16 Small and Wide Angle X-Ray Scattering Applications on Material Characterization

**Buğra Sökmen**[1], Yusuf Özcan[1], Cem Gök[1]
[1]Pamukkale University, Denizli-TÜRKİYE

X-ray techniques are commonly used to determine the characteristics of a wide range of materials. As an addition these analyzes are also useful in determining some failures that occur in materials. There are different types of X-Ray Techniques which are used at studies, such as X-Ray Emission, X-Ray Diffraction (XRD), X-Ray Fluorescence (XRF) and X-Ray Scattering methods. Each one of these techniques proved their worth over the years in their own specific areas which makes them really valuable when it comes to characterization of materials. In this review we mainly focused on Small and Wide Angle X-ray Scattering (SWAXS) method. This technique is a mixture of Small Angle X-ray Scattering (SAXS) and Wide Angle X-Ray Scattering (WAXS). The method determines information about a material's characteric distances, shape, size and the distribution of macromolecules, pore sizes and the surface-to-volume ratio. SWAXS method allows us to make analysis of proteins, nucleic acids, synthetic and natural polymers (both in solid and dissolved forms), nanocomposites and nanopowders. This technique works in a really simple way which only requires an X-ray tube, a collimation system, a beam stop, a sample holder and an X-ray detector. There are also different varieties of tubes, sample holders and X-ray detectors to support the usage of different materials. The X-ray source in the machine carries one of the biggest values during the characterization. In SWAXS method sealed, microfocus and the rotating anode X-Ray tubes are the most used X-ray sources. Alternatively, synchrotron facilities come in great use as an X-ray source when higher photon flux or a different wavelength is required. Synchrotron radiation gained great value over the years thanks to it's usage in diverse research fields such as physics, chemistry, biology, materials science, chemical engineering, environmental engineering, energy resources, mechanical engineering, and electronics.

**Keywords:** X-Ray scattering, Small and wide angle X-Ray scattering, Synchrotron radiation, Material characterization

## P-17 Radiopharmaceuticals for Intelligent Drug Release

**Funda Çakmak**[1], Cem Gök[1], Yusuf Özcan[1]
[1]Pamukkale University, Denizli-TÜRKİYE

The use of radiation provides great benefits to human life. Radioisotope and controlled radiation mostly used in the fields of medicine, industrial application, agriculture and environmental pollution. Medical diagnosis and treatment made by the usage of radiation is the main source of public exposure to artificial radiation sources yet the benefits it provides to human health and life are also enormous. In recent years, lots of important improvements have been made in the early diagnosis and treatment of diseases thanks to the developments in nanotechnology. In addition, with the developments in radiopharmaceuticals and nuclear medicine has been achieved thanks to applications such as targeted drug delivery designed for the specific characteristics of a disease, as well as imaging a specific biological feature in the body. Radiopharmaceuticals are radioactive substances used in medicines for diagnosis and treatment purposes. The use of nanostructures carrying a variety of targeted drugs, genes and imaging agents has opened new possibilities for personalized therapy. With usage of radiopharmaceutical drug delivery systems in medicine, biological barriers in the body are overcome, various anatomical and biological structures such as bronchioles in the respiratory system and tight junctions in the skin are overcome, and targeted diagnosis and treatment is provided with imaging systems. Targeted radionuclide therapies proved it's value over the years and became a very important treatment method, especially in various types of tumors. The aim of radiopharmaceuticals is to optimize the efficacy and safety of treatment and the expectations from these medicines are easy availability, appropriate physical and effective half-life. In this study, the properties of radiopharmaceuticals used in medicine which can be used in targeted drug release systems for the treatment of diseases and their usage are explained. In addition, the factors affecting the use of radioactive materials were investigated.

**Keywords:** Radiopharmaceutical medicines, Cancer, Targeted drug release, Radioactive materials

## P-18 Seasonal Variations of Po-210 and Pb-210 In Sea Urchins and Patella Species in Izmir Bay

Duygu Arslantürk[1], **Aysun Uğur Görgün**[1]
[1]Ege University, Institute Of Nuclear Sciences, Izmir-TÜRKİYE

In this study, Pb-210 and Po-210 concentrations in patella (Patella vulgata) and sea urchin (Paracentrotus lividus) species living in rocky areas in İzmir Bay, Urla were determined seasonally, and the enrichment of these radionuclides in the marine environment was determined within the seasonal cycle. In the literature, there is no data for Po-210 and Pb-210 activity concentrations for patella (Patella vulgata) and sea urchin (Paracentrotus lividus) species on the Turkish coast of Aegean Sea. Polonium-210 was determined by alpha spectrometry using a passivated implanted planar silicon detector (PIPS). In general, the highest Po-210 and Pb-210 concentrations were measured in spring and winter for both species.

**Keywords:** Patella (Patella vulgata), Sea urchin (Paracentrotus lividus), Po-210, Pb-210

## P-19 In Vitro Efficacy of Silymarin Loaded Niosomes in Cancer Treatment

**Yaren Hurma**[1], Emin İlker Medine[2]
[1]Department of Biomedical Technologies, Graduate School of Natural and Applied Sciences, Ege University, 35100 Bornova, Izmir- TÜRKİYE
[2]Department of Nuclear Application, Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

According to the latest data of the World Health Organization, cancer incidence and death rates are quite high and tend to increase. Causing risk factors are smoking, alcohol, obesity, old age, family history and genetics. Pancreatic cancer is among the deadliest cancers. It ranks fourth in cancer-related deaths in the world. Most pancreatic tumors arise from exocrine glands. Many drugs have been developed so far to fight the deadly cancer disease and continue to be developed. However, due to the lack of specificity of chemotherapy drugs, the quality of life of patients is seriously reduced. Nanocarriers have been developed for cytotoxic drugs due to the serious side effects of conventional treatment methods. Nanocarriers prolong the half-life of drugs, reduce nonspecific adsorption, improve serum solubility of drugs, and preferentially deliver drugs to tissues. Implementation of a controlled drug delivery system is the key strategy to increase the efficacy and safety of therapeutic molecules. In this study, it was aimed to investigate the in vitro efficacy of silymarin loaded niosomes in cancer treatment with gemcitabine conjugation. For this purpose, gemcitabine, which is effective in the treatment of pancreatic cancer, was used as a chemotherapy drug. Niosomes were synthesized by thin film forming method. The pegylated niosomes with gemcitabine conjugation to their carboxyl ends were characterized by DLS, TEM, FTIR and XPS methods. Thin-film layer method, which is widely used for niosome synthesis, was preferred. By loading silymarin on niosomes, its anticancer activity is increased. The loading efficiency of silymarin loaded on niosomes was determined by spectrophotometric method of the drug molecules released by detonating the niosomes. Gemcitabine conjugation to niosomes coated with PEG was performed by EDC NHS chemistry. With the synergistic effect to be achieved by using silymarin and gemcitabine together, the effect in the target area was investigated. The cytotoxicity study of the above-mentioned samples on MIA PaCa-2 cells was performed by MTT assay. With this study, a pre-clinical product will be designed for the treatment of pancreatic cancer and it is anticipated that the data obtained will shed light on many studies planned to be done on this subject.

**Keywords:** Niosomes, Silymarin, Gemcitabine, MIA PaCa-2, Pancreatic cancer

## P-20 Investigation of the Antimicrobial Activity of Chlorhexidine Encapsulated Mesoporous Silica Nanoparticles

**Özel Üçton**[1], Emin İlker Medine[2]
[1]Department of Biotechnology, Graduate School of Natural and Applied Sciences, Ege University, 35100 Bornova, Izmir-TÜRKİYE
[2]Department of Nuclear Application, Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

In current study it is aimed to investigate the antimicrobial activity of microorganisms due to oral diseases. Bacterial infections are recognized as serious health problems and cause economic and social complications, attracting significant worldwide attention. The oral biofilm is the habitat for numerous types of bacteria that cause a variety of oral diseases. The resistance developed by microorganisms against antimicrobial compounds complicates oral health and treatment of complications in the oral region. It is important to develop nano-encapsulated drug delivery systems with antimicrobial properties to reduce the side effects of treatments and increase the effect of therapeutic agents. Silver (Ag) nanoparticles are one of the highest potential candidates due to their antibacterial and anti-fungal properties to overcome the developing drug resistances. Among various carriers, mesoporous silica nanoparticles (MSN) are used in biomedical fields as imaging, biosensors, and drug carriers. MSNs show significant advantages over other organic carriers among drug delivery systems due to their high surface areas, adjustable pore sizes, easy surface modifications and superior biocompatibility. MSNs are typically produced with 'inert' structure-directing agents and a sol-gel method to form mesoporous. Thus, it is made suitable for surface modification and drug loading. Hyaluronic acid is a high molecular weight polysaccharide that plays a role in the extracellular matrix. HA has an important role in cellular defense and migration in wound healing and tissue repair by binding to cell receptors. When used in nano-encapsulated drug delivery system, it increases the wound healing process and prevents the diffusion of harmful substances. Chlorhexidine (CHX) is an important medicinal drug, antiseptic, disinfectant, and preservative. CHX has a broad spectrum antibacterial effect with low resistance. In this study, antimicrobial silver nanoparticles were conjugated to mesoporous silica nanoparticles and used to increase the antibacterial activity of microorganisms that cause oral diseases after Chlorhexidine, which does not develop multi-drug resistance and has antimicrobial properties, is loaded. In addition to these studies, after loading Hyaluronic acid, which has wound healing properties, on conjugated silver and mesoporous silica nanoparticles, the antimicrobial activity of microorganisms causing oral diseases was evaluated.

**Keywords:** Mesoporous silica nanoparticles, Silver nanoparticles, Hyaluronic acid, Chlorhexidine

## P-21 In Vitro Evaluation of Radiolabeled Cyclophosphamide Loaded Mesoporous Silica Nanoparticles

Selin Irdel Hamurişçi[1], Burcu Aydın[1], Serap Teksöz[1], **Çiğdem Içhedef**[1]
[1]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

Recently, the possibilities of nanoparticles (NP) in the transportation of therapeutic and target-specific drugs have been increasingly received by scientists and the pharmaceutical industry. Among these carrier systems, mesoporous silica nanoparticles have remarkable properties. Silica nanoparticles are used in various applications in the field of health thanks to their properties such as biocompatibility and low toxicity. Thanks to their porous structure, mesopore silica nanoparticles (MSN) make it easier to load the drug into the system and deliver it to the target area in a controlled manner. In this study, it was aimed to synthesize cyclophosphamide (CPH) loaded mesoporous silica nanoparticles, radiolabeled with technetium-99m and analyze the biological behavior of this structure in vitro. Optimum conditions were determined by examining parameters such as particle size, morphology, drug entrapment capacity of synthesized nanoparticles. Cyclophosphamide loaded mesopore silica nanoparticles (MSN-CPH) were radiolabeled with Tc-99m. After quality control studies, cytotoxicity, and uptake studies of cyclophosphamide-loaded mesopore silica nanoparticles were performed in vitro using MCF-7 and MDA-MB-231 breast cancer cells. Results: The synthesized MSNs have a hydrodynamic radius of 125±3.4 nm according to DLS analysis. SEM images showed that nanoparticles have a spherical morphological structure and distributed between 55 and 70 nm in size. MSN-CPH nanoparticles were successfully radiolabeled with technetium-99m in 99.82±0.25% efficiency. MCF7 and MDA-MB-231 breast cell lines were used for cell culture studies of drug-loaded MSNs and MSNs. When the binding efficiency was compared with respect to cell lines, it was observed that there was no significant difference between the incorporation percentages of MCF7 cells with estrogen receptor and MDA-MB-231 cells with negative estrogen receptor. Radiolabeled MSN-CPH nanoparticles reached the highest level of uptake at 60 minutes in both cell lines. It is thought that the nanostructure synthesized in this study will contribute to the development of new generation radiolabeled nanoteranostic systems with $^{99m}$Tc that can be used in the diagnosis and treatment of cancer in the future.

**Keywords:** Mesoporous silica nanoparticles, Drug delivery systems, Cyclophosphamide, Technetium-99m, In Vitro

## P-22 Variation of Soil Gas $^{222}Rn/^{220}Rn$ Ratios Along The Fault Line

**Ceren Altun**[1], Gülse Masruoğlu[1], Caner Taşköprü[1], Mutlu İçhedef[1]
[1]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

E-W trending İzmir Fault is one of the active fault zones in western Anatolia with a length of 40 km consisting of two segments. The section stretching between Güzelbahçe in the west and Konak in the east is named the Balçova-Narlıdere segment, and the section between Konak and Pınarbaşı is named the Pınarbaşı segment. The studied fault passes into the Izmir metropolis which is under the control of north-south extension, east-west movement, parallel grabens, intervening horsts, and associated normal faults. As reported by GPS-based studies, the Anatolian plate moves approximately 20 mm/year in the east-west direction, and this movement turns into a north-south extension in Western Anatolia. Therefore, the study area has very active tectonics causing hundreds of moderate and high magnitude earthquakes. The earthquake with a magnitude of 6.9 occurred in the north of Samos Island on October 30, 2020, and caused great damage to Izmir. The fact that İzmir is 70 km away from the earthquake epicenter reminded us of the possible effects of an earthquake that will have an active benefit passing through the city center. For this reason, there is a need for all kinds of new information about the İzmir fault, which is an active fault passing through the city center where the densest population lives. In this study soil gas Radon ($^{222}Rn$) / Thoron ($^{220}Rn$) ratios were determined along the Izmir Fault. Both radon and Thoron concentrations in soil air are detected by the RAD7 (Durridge) system. A stainless steel probe (probe) with a diameter of 1 cm was placed in the soil and soil gas measurements were made from 50 to 70 cm depth.

**Keywords:** Radon, Thoron, Fault line, İzmir fault

## P-23 Comparative Investigation of the Radiation Dose Distribution in the Shooting Room During Mammography Procedures

**Barış Cavlı**[1], Süleyman İnan[1]
[1]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

The aim of this study is to analyze the dose scattering that occurs in the shooting room depending on the different dose / extraction parameters made with conventional and digital mammography devices with different technical features during mammography procedures, and to determine how these dose amounts change quantitatively in the shooting room according to distance and patient position. The study was carried out in different hospitals, in different shooting rooms, and dose mapping was done by changing the distances to the device on different axes. According to the results obtained from the study, while the amount of backscattered doses measured at certain distances from the device increased significantly, a general decrease was observed depending on the distance. In addition, the console and shielding properties used by the technician to control the examination process are examined. It is thought that the most appropriate distance, shielding and time factors in accordance with the radiation protection principles determined by the ALARA (As Low As Reasonable Achievable) principle will be examined specifically for breast imaging and the results obtained will benefit the scientific literature with its technical details.

**Keywords:** Mammography, Diagnostic radiology, X-ray radiation, Radiation protection

## P-24 Investigation of Thorium Dioxide Obtaining Conditions from Ammonium Thorium Oxalate Complex Solution

**Selcan Sengül**[1], Yüksel Altaş[1], Hüseyin Tel[1]
[1]Institute Of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

The aim of the present study is to investigate the formation and the degradation mechanism of ammonium thorium oxalate complex, the preparation of thorium dioxide possessing available powder properties for the mixed oxide production starting from this complex and to develop a process to recover oxalate for recycle. In the study firstly Th-REEs oxalates were precipitated quantitatively from a synthetic mixed nitrate solution. The optimum conditions for the dissolution of thorium from Th-REEs oxalate concentrate obtained as an intermediate product to form a stable complex with ammonium oxalate were determined as; temperature: 100 °C, ThOx/AOx mol ratio:1/3, ammonium oxalate concentration: 0.3M, S/L ratio ($g.mL^{-1}$): 1/25, time: 30 min. In these conditions, thorium was separated from cerium and lanthanium with an efficiency of 98,5±2.0%. The structure of the ammonium thorium oxalate complex was determined as $(NH_4)_4Th(C_2O_4)_4.4H_2O$. The degradation of the complex was achieved with acid and alkali addition, obtained thorium oxalate and thorium hydroxide powders and thorium dioxide powders prepared from the calcination of mentioned powders at 650 °C and 900 °C were characterized with thermal, SEM, BET, and FTIR analyses. In the comparison of thorium hydroxide powders, the thorium oxalate precipitate obtained with the degradation of ammonium thorium oxalate complex at pH: 2.22, were determined as easier filterable, having better free flow and more convenient for sintering operation. From the XRD data of the thorium dioxide obtained from the calcination of the thorium oxalate at 900 °C, it was determined that the oxide powders are in the $CaF_2$ type face centered crystal structure with a crystallite size of 1180 Å, a specific surface area of 3.221 $m^2 g^{-1}$ and a mean particle size of 250 nm. The ammonium oxalate concentration for the recycle was determined as 0.33 M.

Acknowledgment: This work was supported by The Scientific and Technological Research Council of Turkey (TUBITAK - Project No: 119M228).

**Keywords:** Thorium ammonium oxalate complex, Formation and degradation mechanism, Thorium dioxide.

## P-25 Nanoencapsulation of Lycopene in Niosomes and Determination of Antitumor Activity on Cancer Cells

**Yaren Hurma**[1], Bekir Cem Kuşdemir[2], Özge Kozguş Güldü[3], Emin İlker Medine[3]
[1]Department of Biomedical Technology, Graduate School of Natural and Applied Sciences, Ege University, Izmir-TÜRKİYE
[2]Department of Biotechnology, Graduate School of Natural and Applied Sciences, Ege University, Izmir-TÜRKİYE
[3]Department of Nuclear Applications, Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

Within the scope of the thesis, it was aimed to determine anti-proliferative and apoptotic effects of phytochemical agent lycopene on the prostate cell lines. Vesicular nano carriers called niosomes were used to maintain stability of lycopene to target to prostate cells and obtain fluorescence images. Monoclonal anti-PSMA antibody conjugation onto niosomes was performed to provide specificity to PSMA + cells, and indocyanine green encapsulation (ICG) was performed for fluorescence imaging. Cellular incorporation levels of the vesicular system were determined spectrophotometrically. Niosome characterization procedures were performed by DLS, SEM, FTIR, XPS, drug encapsulation efficiency and drug release profile study. MTT study was conducted to determine the antiproliferative effect of the characterized niosomes. AnnexinV/7-AAD apoptosis kit was used to determine the apoptotic effect of niosomes. Cellular uptake/association of niosomes was done by fluorescent imaging and fluorescent incorporation study.

**Keywords:** Niosome, Lycopene, Indocyanine green, Prostate cancer

## P-26 Synthesis and Morphological Studies of Tc-99m-Labeled Lupulone-Conjugated $Fe_3O_4$@$TiO_2$ Nanocomposite, and In Vitro Cytotoxicity Activity on Prostate Cancer Cell Lines

**Elif Tutun**[1], Volkan Tekin[1], Volkan Yasakçı[1], Ömer Aras[2], Perihan Ünak[1]
[1]Institute Of Nuclear Sciences, Ege University, Izmir-TÜRKİYE
[2]Memorial Sloan Kettering Cancer Center, USA

Tc-99m-labeled lupulone-conjugated $Fe_3O_4$@$TiO_2$ nanocomposites were synthesized to prepare a multifunctional theranostic probe for magnetic resonance imaging (MRI) and single-photon emission computed tomography (SPECT) and photodynamic therapy. Lupulones are molecules extracted from hops, which have been reported to contain hundreds of valuable ingredients that have a positive effect on health such as sedutive, diuretic, antibacterial and anticancer properties. It is expected that the obtained results could be used to determine the theranostic potential of lupulone-modified $Fe_3O_4$@$TiO_2$ nanocomposites in prostate cancer. $FeCl_3$, $FeCl_2$ and $TiCl_4$ solutions were combined and then methanol was added dropwise; the final solution was stirred for 1 h. Then distilled water and dodecylamine were added, and the solution was restirred at 800 rpm for 1 h at 100 $^oC$. After the synthesis of $Fe_3O_4$@$TiO_2$ nanocomposites, surface modification was performed whereby ammonium hydroxide and TEOS were added to stock solution. Then, the mixture was incubated for 12 h at 40 $^oC$. After 12 h, solution was mixed with APTES for silanation and incubated for 12 h at 60 $^oC$. For the synthesize lupulone derivatives, sodium hydroxide and ammonium chloride were combined with stirring and heated at about 100 $^oC$. After dissolving phloroglucinol in anhydrous diethyl ether, liquid ammonia was added dropwise from the distillation unit under a dry nitrogen. The solution was stirred for 15 min, and then 1-bromo 3-methyl butane dissolved in anhydrous diethyl ether was slowly added. The temperature was fixed at -78 $^oC$ for 5 h. For acetolupuphenone synthesis, 2’4’6’- trihydroxyacetophenone monohydrate was added instead of phloroglucinol. FTIR (Fourier-transform infrared spectroscopy) analyses confirmed expected molecular structures. SEM and TEM images presented that nanoparticles are spherical formed nanostructures. Cytotoxicity studies were done with PC3 and RWPE-1 human prostate cell lines. $Fe_3O_4$@$TiO_2$ nanocomposites were shown to be an efficient lupulone-loading platform to successfully develop lupulone-modified $Fe_3O_4$@$TiO_2$ nanocomposites. As conclusion, lupulone-modified $Fe_3O_4$@$TiO_2$ nanocomposites have a potential as theranostic for imaging with MRI as well as to enable photodynamic therapy and magnetic hyperthermia. They also exhibited low cellular toxicity. Lupulone-modified $Fe_3O_4$@$TiO_2$ nanocomposites may thus serve in the future as a multifunctional probe for PET/MRI, photodynamic therapy, and hyperthermia therapy of cancer.

**Keywords:** $Fe_3O_4$@$TiO_2$, Lupulone, Nanocomposites, Prostate cancer cells, Tc-99m

## P-27 Determination of Mineralogically Linked Radiological Characteristics of Commercial Natural Structural Stones Used in Turkey

Yasemin Camgöz[1], **Günseli Yaprak**[1], Berkay Camgöz[1]
[1]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

In the last few decades, the ionizing radiation is widely used in various scientific and industrial fields as well as in medicine, diagnosis and treatment. However, radiation protection has been a major concern. Three main methods for protection from radiation are usually utilized; these are time, distance and shielding. Among the three methods, shielding is the most important in which shielding materials become important. Buildings, where people spend 80% of their time, have a shielding effect against cosmic rays and terrestrial gamma radiation and reduce the exposed dose in the indoor environment. Generally, studies related with commercial natural stones such as granite, marble, travertine etc. used in buildings have been based on the $^{222}$Rn, $^{226}$Ra, $^{232}$Th and $^{40}$K radionuclide contents and the doses taken from these sources. On the other hand, there are a limited number of scientific studies with the gamma attenuation of these materials and also in these studies, sample diversity is narrow and also the mineral, compound / element contents and ratios of the natural stones are not taken into account. In the proposed project the gamma attenuation of commercial natural stones will be evaluated together with the mineral content, composition and structure of these materials in a large sample pool. In the study, attenuation coefficients of commercial natural stones for 59.6 keV, 661.66 keV and 1332.5 keV gamma energies will be determined experimentally using narrow-beam photon geometry and compared with XCOM theoretical values calculated using mineralogical variables for each material. By the proposed project, the protection performance of natural stones as shielding material against to ionizing radiation, which have an important share in our foreign trade with their rich diversity and quality, will be evaluated.

**Keywords:** Natural stones, Mass attenuation coefficient, Gama absorption, Radiation shielding, Mineralogy

## P-28 Synthesis, Radiolabeling and Investigation of Bombesin-Modified Gadolonium Nanoparticles As SPECT/MRI Agent on Prostate Cancer Cell Lines

Talha Sıddık Akkaya[1], **Elif Tutun**[1], Volkan Yasakçı[1], Perihan Ünak[1]
[1]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

We aimed to prepare a multifunctional diagnostic probe for magnetic resonance imaging (MRI) and single-photon emission tomography (SPECT). For this purpose, Tc-99m-labeled bombesin-conjugated gadolinium nanoparticles were synthesized and radiolabeled with Tc-99m. Gadolinium and iron-based nanoparticles are the most suitable elements to be used as MRI contrast agents and bombesin is a peptide originally purified from frog skin which is abundant in prostate and breast cancer. Results could be used for new multifunctional probe for single-photon emission tomography SPECT/MRI and therapeutic nanoparticle system in the future as a promising agent. $Gd(NO_3)_3$ and $Mg(NO_3)_2$ were dissolved in ultrapure water. Then under nitrogen gas flow, NaOH solution was manually added and the pH was kept between 6.5-7.0 and stirred at 120 $^oC$ for 24h. The final solution was washed with ultra-pure water and dried with nitrogen gas. For surface modification, $Gd_2(OH)_5NO_3$ nanoparticle was mixed with distilled water and 2-propanol was added to the resulting suspension. The suspension was stirred at room temperature, at 700 rpm, and $NH_4OH$ and TEOS solution were added and incubated for 6 h at room temperature. After incubation, the product was washed twice with ultrapure water. CTABr was added to the solution containing propanol and $NH_4OH$ in the obtained pellet. Then the solution is 30 min. stirred at room temperature. TEOS was added dropwise into the solution and incubated for 6 hours. CDI, NHS, MES, NaCl were taken into the container and dissolved by adding PBS. DFO/ultrapure water solution was added into the $Gd_2(OH)_5NO_3$-$SiO_2$ solution. Then, solution was incubated in a shaker for 2.5 hours. After incubation, the product (GdO@SiO-NP-DFO) was stored at -20 °C. Radiolabeling with Tc-99m were successfully carried out with 93% efficiency. FTIR (Fourier-transform infrared spectroscopy) analyses confirmed expected molecular structures. SEM and TEM images presented that nanoparticles are spherical shaped formed nanostructures. Studies were conducted on healthy (RWPE-1) and cancer prostate cell lines (PC-3 and LnCaP) to determine in vitro biological behavior of the nanoconjugates. $^{99m}Tc$ radiolabeled DFO-Bombesin-GdO@SiO-NP nanoconjugates may be a promising novel multifunctional probe for single-photon emission tomography SPECT/MRI and therapeutic nanoconjugates in future.

**Keywords:** Gadolonium nanoparticles, Bombesin, SPECT/MRI agent, Tc-99m

## P-29 Tomography with Different Number of Detectors Patient Dose and Cancer Risk Ratio

**Mehmet Erkek**[1], Fatma Yurt[1]
[1]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

In this study, we aimed to calculate the organ-based radiation doses received by patients in lung tomography scans taken on two Computed Tomography devices with different detector numbers (16 – 64x2) and to estimate the potential risk of lung cancer due to age and gender and to establish a local diagnostic reference level. Routine lung tomography was compared in 16-detector and 64-detector devices. This comparison was made using Dicom data that came with images of patients. Since the CT dose descriptor required for risk analysis was the dose absorbed by the organ, the data were transferred to DoseWatch (FDA-approved Dose Monitoring Software) software. Patient size-specific dose estimation (SSDE) was calculated. Lung tomography of both devices determined local diagnostic reference levels (LDRLs) CTDIvol and DLP for the adult patient. To estimate the potential risk of radiation-induced lung cancer, the model proposed by BEIR VII was used to predict the lifetime attributable risk of an individual developing cancer. In the examinations examined, DRL (Diagnostic Reference Level) calculations were made in men and women over 21 years of age in 16 and 128 slice Tomography devices of adult patients in the same sex group over 21 years of age (median value of SSDE CTDIvol and DLP dose values of total patients in the same group). Again, when the organ-based dose values were compared in the lung tomography taken in both devices, it was found that the organ-based dose values of the tests taken in 16 cross-section devices were higher. The risk assessment, which was carried out using the extraction parameters of patients with the same sex, age group and body mass index, showed that the lifetime attributable risk of cancer for both men and women decreased with patient age for lung tomography protocols. The comparison of cancer risk ratios based on calculated organ doses was higher in 16-slice devices.

**Keywords:** Tomography, Radiation dose, Cancer risk, Radiation protection, Diagnostic reference level

## P-30 Investigation of The Effects of Iterative Reconstruction Models on The Amount of Backscattered Radiation for Computer Tomography Scans

**Murat Dündar**[1], Elçin Ekdal Karalı[1]
[1]Institute of Nuclear Sciences, Ege University, Izmir-TÜRKİYE

Iterative reconstruction techniques have emerged recently, and their main purpose is to reduce the amount of ionizing radiation dose without the image quality. The method is a mathematical iterative reconstruction algorithm technique to reduce the noise ratio of the raw data obtained in CT detectors, to obtain images with high contrast or spatial resolution. Less dose and better-quality image are meant by imaging compared to the filtered back projection reconstruction algorithm technique used in normal Computed Tomography scans. Considering the high rate of CT scans in radiological scans and the relationship between the amount of radiation and the risk of causing cancer, the importance of iterative reconstruction technique and dose-reducing techniques. In this study, which was made with calibration phantom measurements, improvements in the amount of noise were shown by reducing the amount of radiation dose.

**Keywords:** Computer Tomography, Iterative reconstruction, Secondary radiation

# AUTHOR INDEX

**Z**