

شبكة المعلومات الجامعية التوثيق الإلكتروني والميكروفيلو

بسم الله الرحمن الرحيم





MONA MAGHRABY



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جامعة عين شمس التوثيق الإلكتروني والميكروفيلم قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات



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Characterization of Some Nuclear Material Samples for Nuclear Forensics Investigation Purposes

A Dissertation Submitted for the Degree Doctor of Philosophy in Nuclear physics

BY

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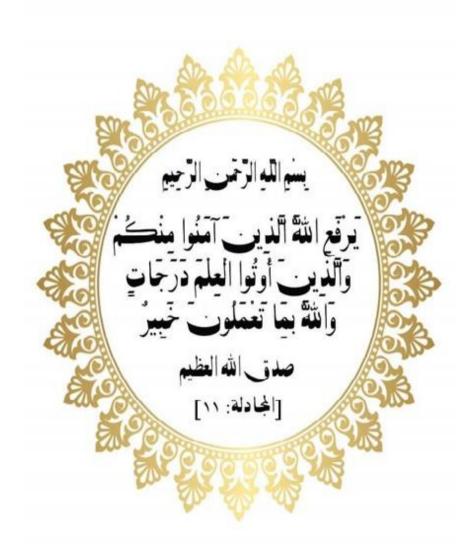
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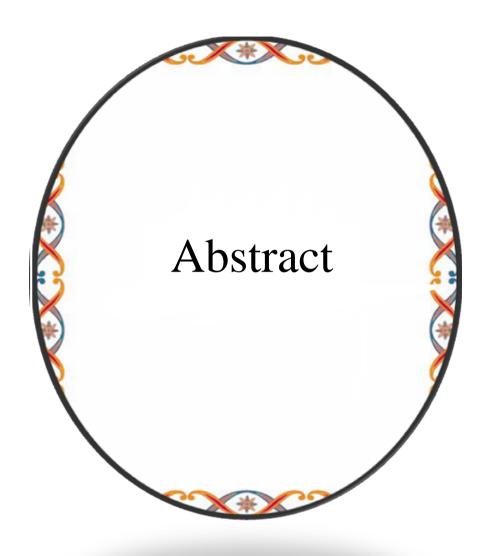
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Abstract

Human needs for nuclear and radiological applications are extremely extended in all aspects of life. This includes generation of energy, medical diagnosis and treatment, research and development, optimize the use of natural resources, sterilization and many other applications.

Beside the huge benefits of nuclear and radiological applications, the inability of controlling them may impose hazards to human, property and environment. Normally, for any activity which includes benefits and hazards, laws and regulations should be established for regulation.

The three main pillars to regulate the applications of Nuclear Material (NM) and Radioactive Sources (RS) are safety, safeguards and security. While safety systems are constructed to prevent and minimize the misuse of NM and RS, safeguards and security systems focus on deter, prevent and detect any unauthorized uses or acts out of regulations. The main target of the safeguards system is to assure the non-proliferation of nuclear weapons. The acts which are targeted by security systems include the theft, sabotage, unauthorized access, illicit trafficking and other malicious acts involving NM and RS.

One of the main components that should be available to control NM and RS; and their applications through the three above mentioned systems is a measurement system. The function of this system is not only to verify the correctness of information regarding NM and RS, but it must be capable to characterize the unknown (or orphan) sources as well. In addition to chemical and physical properties resulted from the characterization process, in some cases, other information may also be needed such as the origin of the measured sample and its age. This information is an output of a nuclear forensic regime, which in its turn an essential element of the nuclear security system.

Nuclear Forensics is defined as a methodology that aims to re-establish the history of NM of unknown origin. It is based on indicators that arise from known relationships between material characteristics and process history. Nuclear forensics analysis includes the categorization and characterization of the seized material and correlation with production history followed by nuclear forensic interpretation.

NM characterization is an essential activity for both nuclear safeguards and forensics purposes. In addition to national obligations, a State nuclear regulatory authority may have additional international responsibilities that are necessary it to implement an inspection regime. NM verification and sometimes characterization is an essential activity in this regime. In some cases, the age determination of NM sample could provide some explanation about its declaration, for example most orphan samples might be declared after local laws and/or international agreements came into force just because they were prepared long time ago before the existence of any legally binding instruments. On other hand, nuclear forensics entails the analysis of intercepted illicit nuclear or radioactive material and any associated material to provide evidence for nuclear attribution. It employs measurement and analysis methods to reveal as much information as possible about a NM of unknown origin (e.g. seized material) in order to aid the authorities in criminal investigation as well as in determining the history and the origin of the material. Correlation of the measured signatures with the origin of NMs, their history and age of production could help to understand the intended use of such material. Age dating (i.e. determination of the elapsed time since the last chemical purification of the material) is one of characteristics or signatures important

to deduce the history of NMs for safeguards and nuclear forensics applications.

An absolute non-destructive analysis (NDA) method based on gamma ray spectrometry was used to characterize some plutonium-bearing samples and to determine their radiochronometry (i.e., age dating). The proposed method is fast in comparison with destructive methods, does not require any reference materials, and could be applicable to Pu-material of any physical and chemical form.

The assayed samples have been characterized using Falcon 5000 Portable HPGe-Based Radionuclide with the In-Situ Object Counting System (ISOCS) which is based on a pre-efficiency calibrated high-resolution gamma-spectrometer in combination with analysis software. The determined ages were compared to those obtained using the "Multi-Group Analysis (MGA)" Code.

The activities of the samples for ²⁴¹Pu found in the between 913.79±339.76Bq samples ranged 46627.10±14.99Bq with average of 11257.03±63.19Bq, ²⁴¹Am found in the samples ranged between 455.97±0.009Bq and 11271.50±0.009Bq with average of 3717.92±0.009Bq, ²³⁹Pu found in the samples ranged between 3552.48±0.76Bq and 70143.27±0.73Bq with