Contribution ID: **157** Type: **Oral Presentation**

Study of fast neutron irradiation induced damage on Graphite and Zircaloy-4

Friday, 12 July 2013 10:50 (20 minutes)

Abstract content
   (Max 300 words)

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ABSTRACT

In order to understand the damage effects on nuclear reactor core structural materials by fast neutron irradiation, the South African Nuclear Energy Corporation (Necsa) in collaboration with the University of Johannesburg (UJ) commenced a study of fast neutron irradiation damage on graphite and zircaloy-4. Due to their unique neutronic and physical properties, graphite is used as a moderator and a reflector, while zircaloy-4 is used as a clad material for the fuel element in the reactor core. The damage of these materials is to be achieved through the use of the radio-frequency quadropole (RFQ) accelerator located at Necsa. The accelerator produces neutrons with an energy range of 1 to 10 MeV, dependent on the nuclear reaction chosen, with an associated neutron flux of about 1010 to 1012 neutrons per second (n/s) [1].

When these in-core structural materials are irradiated by fast neutrons in the reactor, physical property changes occur due to the damage caused by this radiation. The intention here is to effect the damage with the use of the accelerator as the damage can be achieved faster. Such changes have been observed in other materials and include harderning and embrittlement, creep and dimensional changes of the materials [2,3]. The focus of this study is to report on the mechanisms by which these changes occur and their effects on the reactor core materials.

In order to characterize the damage after irradiation, surface and structural analysis of the materials will be conducted. Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM) will be used for the analysis of the surface , while for the bulk crystal structure, X-ray diffraction, Raman spectroscopy and Ion-beam channeling will be exploited.

[1] C.B. Franklyn, G.C. Daniels, Characterisation of an accelerator based fast neutron facility, Proceedings of FNDA2011, Ein Gedi, Israel

[2] P.Rodriguez, R.Krishnan and C.Sundaram. Radiation effects in nuclear reactor materials – correlations with structure, Bull Material Science 6:339-367, 1984

[3] D.G.Cacuci, Hand

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Session Classification: NPRP

Track Classification: Track B - Nuclear, Particle and Radiation Physics