Analysis of complex nuclear materials with the PSI shielded analytical instruments

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The detailed characterization of modern nuclear materials is becoming more and more demanding due to their increasing structure and composition complexity. A detailed characterization is often no more possible with a single instrument and request the use of different techniques.

The PSI hot-laboratory is equipped with shielded analytical instruments for the characterization and analysis of highly radioactive materials. The application of different methods like Optical Microscopy (OM), Electronic Microprobe (EPMA) and Secondary Ion Mass Spectrometry (SIMS) allows a very detailed and local characterization of the material structure as well as the elemental and isotopic composition of the surface.

The main characteristic of the shielded analytical instruments available in PSI hotlaboratory will be shortly presented and illustrated by studies realized on complex nuclear materials like high burnup fuel or remnant of severe accident tests (PHEBUS-FP).

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Session 3: Post-Irradiation Examination Techniques. Co-chairs: Paul Coad, Dawn Janney

Seven papers were presented in the session on Post-Irradiation Examination techniques. For the most part, the papers emphasized newly developed advances in instrumentation or measurement techniques rather than presenting examination results.

Marcel Parvan presented results from a Romanian-Canadian collaboration in which a CANDU-6 fuel bundle had been cycled from 50% to 100% power on a daily basis for 200 days as a load-following test. Post-irradiation examination (PIE) techniques included visual inspection, optical microscopy, profilometry, gamma scanning, fission gas analysis, and quadrupole mass spectrometry.

Akio Harada presented a paper by Onozuwa et al. describing development of an approach to examining the radial distribution of hydrides using back-scattered electron images at JAEA's Reactor Fuel Examination Facility. The talk described details of sample preparation and errors resulting from improper preparation, and addressed some considerations for automated image processing. Mr. Harada received the conference's Young Investigator Award for his presentation.

Yury Goncharenko presented a paper describing current research in development of crystallographic preferred orientation ("texture") during irradiation of zirconium alloys at the State Scientific Centre of Russian Federation Institute of Atomic Reactors. Understanding development of this texture is crucial for predicting deformation during irradiation. However, measuring textures of irradiated materials is difficult, and development of new techniques continues.

Daniel Kuster and co-authors report recent development and successful testing for a new technique for fuel rod profilometry in the hot cell at the Paul Scherrer Institute. The technique uses a laser, and differs from other methods in that it does not require contact with the fuel pin during measurement.

Lionel Gosmain described recent development of Raman spectroscopy capabilities as an alternative to X-ray diffraction for understanding radiation damage at the LECI laboratory. The primary advantage of the newly available technique is its ability to obtain data from areas as small as a few square micrometers and volumes as small as 10 cubic micrometers.

Boris Meunier presented a paper on new capabilities obtained by adding a micro gas chromatography device to the MERARG annealing device at the CEA laboratories in Cadarache. The new device makes it possible to measure stable gases, including helium.

Didier Gavillet presented a review of the capabilities of the shielded analytical instruments in the hot laboratory at the Paul Scherrer Institute. These instruments include an optical microscope, a microprobe, and a secondary ion mass spectrometer. In

combination, the techniques allow detailed characterization of microstructures, including elemental and isotopic characteristics of specific local areas.