

The CEA Nano-characterization platform for irradiated materials of the LECI Nuclear Material Department

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Introduction

The Nuclear Material Department (DMN) of CEA Saclay is invested in a new nano-characterization platform for irradiation effects analysis. It is composed of a nuclearized Atom Probe Tomography (APT), a Transmission Electron Microscope (TEM), a high resolution Scanning Electron Microscope (SEM) and a Focused Ion Beam (FIB) microscopes coupled with a SEM column.

Infrastructure

The goal of this platform is to investigate the irradiation effect on materials from the micron to the atomic scale which require safe and accuracy sample preparation method. This role is performed with the FIB/SEM to prepare the smallest volume of material required for analysis and to limit its activity. This equipment will perform sampling in specific areas of interest (grain boundaries, crack areas, etc) on any kind of materials (ceramic, metal, oxide) after neutronic irradiation and/or mechanical treatment. Moreover it will perform 3D tomography analysis of the morphology and crystalline structure with a high resolution field emission gun associated to SE, BSE, SESI and EBSD detectors.

To ensure containment of the radioactive sputtered material and to protect equipment and personal of radioactivity the FIB/SEM is connected to a sealed gloves box and both will be located in a first hot cell shielded with 150 mm lead. A door DPTE type system separate FIB chamber to the gloves box, to allow the maintenance of the equipment inside the cell. A second hot cell is in contact with the first one. It will be used to receive samples from the transfer area to clean, prepare and store them before their introduction in the first cell through a sealed tunnel.

The transfer of the FIB holder with finals TEM and APT samples is provided by a sealed container which will be safely connected in the front of the cell via a door DPTE type. Another gloves box will be designed to receive this container and to transfer the final samples from the FIB holder to dedicated TEM or APT holders. Moreover this box will be used to store samples in clean condition and to control the lack of dust spread on finals samples before they exit from the gloves box. This box is in project as the nuclearisation of the APT until the end of 2015. The APT is used since April 2013 to investigate the composition of cold nuclear materials and to understand the atomic organization in ODS steels, aluminium alloys, zirconium alloys, etc.

Conclusion

Thanks to this new platform composed of the most powerful techniques for nano-analysis, the CEA will access to new information on irradiated materials as atomic diffusion, structural and morphological evolution from the micron to the atomic scale. This nano-characterization platform will be operational in late 2015 and the first analysis on irradiated materials are expected early 2016.

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