Small-scale materials testing on irradiated materials for nuclear applications and the investigation of new materials concepts*

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Abstract

Testing of reactor-irradiated materials for nuclear applications (fission and fusion) are cost and labour intensive tasks. Large-scale materials testing requires the handling of large amounts of highly radioactive materials. Using small-scale materials testing can reduce the amount of active material and allow for relatively inexpensive lower energy irradiations. Today modern focused ion beam (FIB) based techniques allow one to perform compression testing on a true μm to nm scale while getting more data on the same sample. This technique in combination with nanoindentation and a good microstructural characterisation involving microscopy techniques as well as local electrode atom probe allows one to reduce the amount of material needed to assess the materials degradation after irradiation.

In addition, small-scale testing techniques coupled with using low-energy ion beam accelerator irradiations with limited penetration depth to get initial data on materials irradiated to high dose without activating the samples.

In this presentation we show a direct scale comparison (micro to macro) of highly irradiated ferritic/martensitic steels, allowing one to gain confidence in these new techniques.

Small-scale materials testing in combination with ion beam irradiations enables the investigation of new alloys for radiation tolerance. In recent times it has been shown that oxide dispersion strengthened steels have superior radiation tolerance where the oxide-metal interface acts as defect sinks and He traps. However, we investigate the possibility of using intermetallic precipitates in a metal matrix to achieve similar properties since intermetallics can be formed within the alloy itself.

* The full paper being unavailable at the time of publication, only the abstract is included.