INTERNATIONAL NUCLEAR ENERGY RESEARCH INITIATIVE

Development of Microcharacterization Techniques for Nuclear Materials

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This project will systematically investigate small-scale materials testing of structural materials for nuclear application, evaluating the full potential of these methods and standardizing the techniques for irradiated materials. The goal is to develop micro/nano-scale mechanical testing techniques (tensile, compressive, and creep) for irradiated materials that will allow researchers to assess mechanical property changes on the macro scale.

Degradation of materials properties under neutron irradiation is a key issue limiting the lifetime of nuclear reactors. Evaluating the property changes of materials due to irradiation and understanding the role of microstructural changes on mechanical properties are required to ensure reliable long-term reactor operation and to develop high-dose concepts. Researchers have been conducting post-irradiation mechanical testing on bulk specimens for decades, but the task remains time- and cost-intensive. It is also challenging, given the need to handle large quantities of radioactive materials. While ion beam irradiation does not result in activation of the materials, the irradiated volume is often too small for conventional mechanical testing. Small-scale materials testing has recently been applied to nuclear materials and shows potential to address these issues. While initial studies are promising, this technique is far from being fully developed or standardized. Developing these techniques as part of an international collaboration is significant, as it is a step towards global acceptance of a more standardized and unified approach in mechanical testing for nuclear materials. The project consists of the following major tasks:

- Fabricate micro/nano-scale testing samples and conduct initial multiscale testing of the unirradiated materials.
- Perform ion beam irradiation of the materials.
- Conduct materials testing of the ion beam irradiated samples and compare with modeling results.
- Conduct small-scale materials testing on materials irradiated in a reactor.