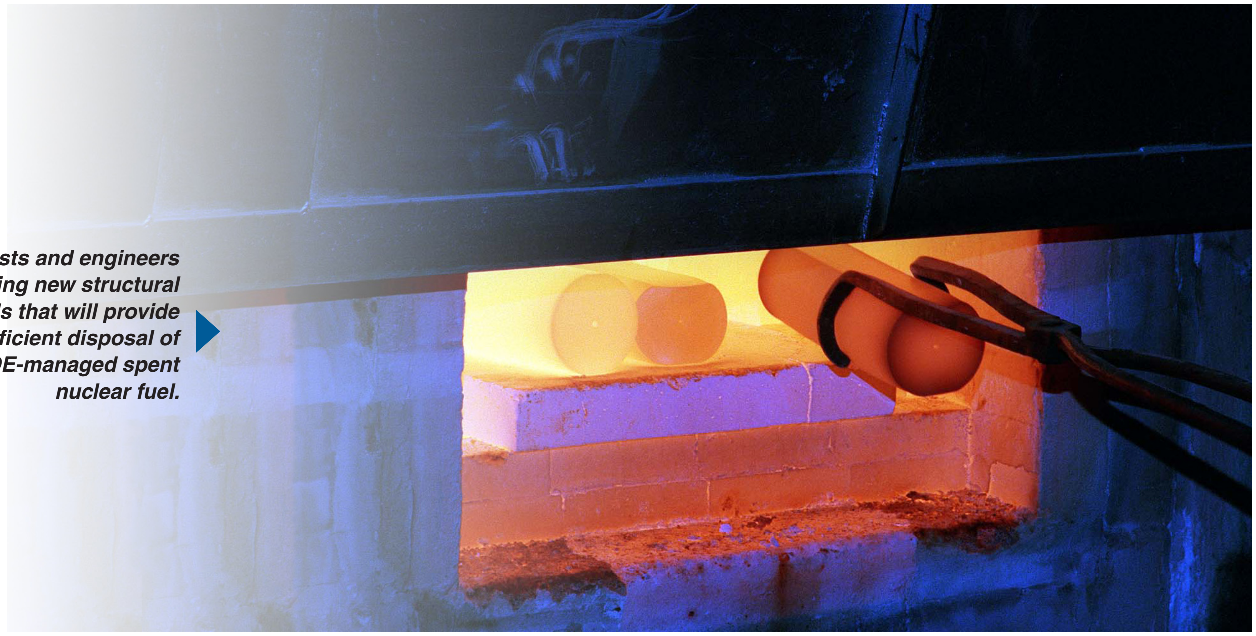


INL scientists and engineers are creating new structural materials that will provide efficient disposal of DOE-managed spent nuclear fuel.

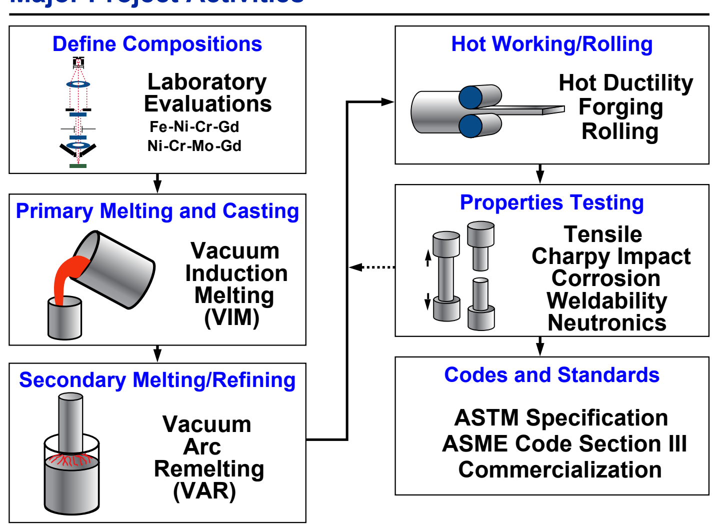
Advanced Neutron Absorber Project

Improving spent nuclear fuel disposal by developing Advanced Neutron Absorber (ANA) material that is weldable and corrosion resistant is the INL's Nuclear Materials Disposition and Engineering department's goal.

Purpose of the Project

Safe, long-term disposal of the U.S. Department of Energy (DOE)-owned spent nuclear fuel requires a corrosion resistant, long-lasting material that absorbs neutrons emitted by spent nuclear fuel. The National Spent Nuclear Fuel Program (NSNFP) at the INL is developing gadolinium-alloyed nickel-based alloys for potential use as a neutron absorber structural component. This alloy would be used for packaging, storage, and long-term disposal in the Yucca Mountain Repository. In the disposal setting, nuclear criticality control would be implemented based on welded fuel baskets that will be placed in the standardized canister.

Major Project Activities



ANA development activites.

New Alloy

The new alloy is described as an advanced neutron absorber (ANA) and is based on the Ni-Cr-Mo alloy system with a gadolinium addition. Gadolinium was chosen as the neutron absorption alloying element because of its high thermal neutron absorption cross section and its chemical stability in the disposal setting. The alloy development activities are shown in the above figure.

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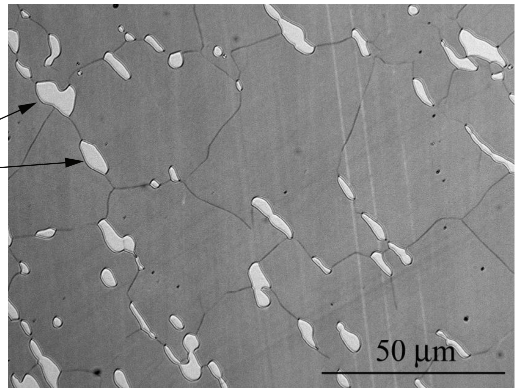

Light optical microscopy (LOM) image of Ni-Cr-Mo-Gd alloy microstructure.

The figure above shows a typical microstructure for the Ni-Cr-Mo-Gd alloy, consisting of a darker region, known as the Ni-Cr-Mo austenitic matrix, and a lighter region, known as the dispersed secondary phase. This dispersed secondary phase has a hexagonal crystalline structure with a chemical composition of Ni5Gd.

This secondary phase, referred to as a gadolinite, is found at the austenite grain boundaries. The ANA alloy can be described as one containing a hard-dispersed secondary phase within a softer, ductile austenitic matrix.

Consensus Standards

The ANA (Ni-Cr-Mo-Gd) alloy chemistry requirements are defined in American Society for Testing and Management B932-04. The mechanical and physical property requirements and American Society of Mechanical Engineers design allowables are defined in ASME Code Case N 728, which is for unwelded applications.

Applications

The ANA alloy will be used for the internal, spent nuclear fuel (SNF) baskets that will be inserted into the DOE standardized canisters. These standardized canisters will be used for storing DOE-owned SNF prior to disposal. The main functions performed by these baskets include structural support of the fuel assemblies and nuclear criticality control by providing geometry control and by the neutron absorption capability of the gadolinium. This ANA alloy has also been considered for other SNF types including commercial light water reactor fuels.

Unique Capabilities

The gadolinium addition provides greater thermal neutron-absorption capabilities than borated neutron-absorbing materials. In the disposal setting, gadolinium is not transported from the waste containers. The ANA material is considered to be weldable, and an extension to ASME Code Case N-728 is being pursued for welded construction.

For more information

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