



U.S. DEPARTMENT OF
ENERGY

Nuclear Energy

Abstract

This presentation summarized materials conditions for application of nanomaterials to reactor components.



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Fuel Cycle Research and Development

Mechanical Properties/Structures

Stuart A. Maloy
LANL

■ Overview talks

- DOE-NE Structural Materials Research, Materials Challenges and Operating Conditions
- Additive Manufacturing
- NFA-alloys
- Powder development through Gas Atomization

■ Nanomaterial Categories

■ Nanomaterial Applications

■ Interfaces



■ Why nano ?

- improved high temperature strength
- improved radiation tolerance
- materials in metastable state may have improved corrosion or other properties
- improved methods of material production and characterization
- coupling with atomistic models.

■ What are the issues and challenges?: costs, availability-manufacturing, processing, fabrication joining, uniformity, balance of properties (what properties are important limiting), qualification, codes, safety, quality assurance, supply chain...

■ Structural Applications

- application to ATF cladding and improved operational performance (e.g. improved safety)
- application to fast reactor cladding (high dose is goal)
- application to improved materials for heat exchangers (CO₂, liquid metals, VHTR's etc.) (high thermal conductivity/high strength materials) – Ex.-BN
- valves, coolant piping

■ Coatings and Barriers (coating to act as diffusion barrier)

- FCCI barrier
- improved coated cladding
 - *reduce grid to Rod Fretting*
 - *improved high temperature oxidation in steam (ATF cladding) – avoid ballooning before rupture (improved strength as well)*
- add material to the coolant that creates a coating for corrosion resistance
- thermal spray coatings to repair steam generator tubing or improved corrosion resistance
- improved corrosion resistance coolant piping/cladding (e.g. graphene, hydrophobic coatings)

■ Sensors and In-service Monitors

- monitor temperatures in fuel? (optical fibers/alumina)
- monitor flux and radiation
- in situ corrosion sensor
- stress/strain monitor (look at stress in CNT coatings)
- in situ sensors for chemistry (e.g. hydrogen)
- monitor degradation in concrete (electrical conductivity/ultrasonic)

■ Composite/Hybrid Materials

- functionally graded coatings for cladding
- composite materials with to improve conductivity (e.g. improve conductivity of zircalloy, improve TC of refractory metals)
- bigger impact with fuel – interface with fuel
- improved heat exchangers