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Distributed molten salt-loop development acceleration with single-crystal harsh-environment optical fiber-sensors

Technology Summary

- New single-crystal fibers withstand harsh nuclear core conditions
- Distributed optical interrogation enables precise core and coolant control
- Allows measurement of loop temperatures, piping strain, or other important parameters

Technology Impact

Reactor automation accelerates Molten Salt Reactor designs, ushers in a new paradigm of distributed core-monitoring

Technology Highlights

- Sensor fibers produce thousands of data points to aid reactor designers or improve reactor operational awareness
- New cladded single-crystal optical fibers are grown specifically for molten-salt environments
- Gathering thousands of data-points to map reactor coolant-path temperatures or other parameters
- Mapping in-core temperature distributions
- Next-gen sensing replaces single-point sensors like thermocouples
- Providing data to guide reactor design and improvement through thermal efficiency

Distributed Raman Interrogator

- Thousands of data points over tens of meters of crystal fiber
- Fast data acquisition times (2Hz)
- Only one fiber-feedthrough required
- Compact rack-mount design
- Long-life operation

Novel cladded single-crystal sensor fibers

- Fibers grown using Laser-heated pedestal growth
- Sapphire and YAG (single crystals) operate at high temperatures/radiation loads
- World's longest single-crystal fibers (NETL)
- Novel Optical Claddings for high-temperature operation while encased/embedded in components
- Enabling sensing in unexplored harsh-environments
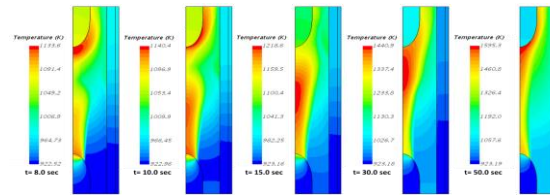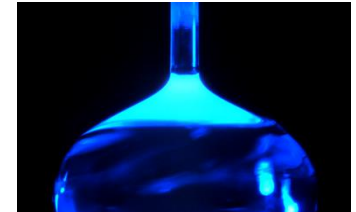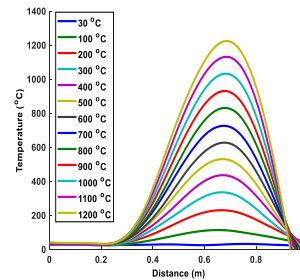
Top Left: example distributed measurement.

Top right: closeup of single-crystal fiber grown from source material. Bottom Right: NETL laser heated pedestal growth system.

Bottom left: **In depth core modelling predicts best locations for sensor fibers: Unprotected LOF** (Decrease of fuel salt flow rate to 80 % exponentially with time constant of 5 sec)

With Pattrick Calderoni (INL), Ruchi Gahkar (INL), and Koroush Shirvan (MIT) (co-PI's)
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