NUCLEAR ENERGY RESEARCH INITIATIVE

Silicon Carbide Ceramics for Compact Heat Exchangers

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Project Number: 05-032

Collaborators: None

Related Program: NHI

Project Description

In support of DOE's need for high-temperature, compact heat exchangers for the next generation of nuclear plants, this project will develop revolutionary, cellulose-derived-carbon (CDC), silicon carbide (SiC) materials and structures that are impervious to hot hydrogen gas. SiC materials offer a 10-fold improvement in thermal conductivity over nickel super-alloy, but existing manufacturing technology does not support the production of acceptable quality block materials. The unique CDC-SiC materials and manufacturing approach that will be used in the project will permit the development of net-shaped SiC structures and assemblies suitable for use in compact heat exchanger components.

In addition, this project team will develop glass-sealing technology that is critical to sealing residual porosity in the silicon carbide, in order to make hydrogen-impervious seals. These seals have the potential for sealing between ceramic and metal components. Successful completion of this project will enable the development of a new generation of heat exchangers that are capable of continuous operation at temperatures over 900ºC.

Work Scope

Following is the work scope of this project:

- Develop models to define the optimum channel configuration for SiC including pressure drops and heat transfer rates related to the configuration and geometry
- Synthesize materials to develop CDC-SiC materials for compact block-design heat exchangers
- Characterize materials to define micro-structural material and thermal and mechanical properties, and to measure gas permeability
- Manufacture a heat exchanger prototype
- Test the heat exchanger to determine heat transfer capability and pressure drops
- Compare experimental data to model predictions.