Dow Corning Corporation

Polymer Impregnation and Pyrolysis

CFCC

Objective

Dow Corning Corporation is leading an industrial team effort to develop continuous fiber ceramic composites (CFCCs) for industrial application using the polymer impregnation and pyrolysis (PIP) process.

Materials and Processes

The PIP process is a versatile method to fabricate large, complex-shaped structures. In comparison to other ceramic composite fabrication process, the PIP process offers significant flexibility. The process uses low-temperature forming and molding steps typically used in the fabrication of polymer matrix composites.

More specifically, a matrix polymer is first impregnated into a fiber architecture, and cured using conventional methods. Both the initial shaping and fabrication of the composite are carried out using low-temperature processing equipment. Preforming methods can include filament winding, 2-D weaves, braids, and 3-D weaves. The composite is then heated to temperatures greater than 1000°C to pyrolyze the pre-ceramic polymer, converting it to a ceramic. Subsequent impregnation and pyrolysis steps are carried out to achieve the desired final density.

Applications and Benefits

CFCCs fabricated by the PIP process exhibit both high strength and tough composite behavior to 2200°F. The Dow Corning team is applying this technology to several industrial applications:

- CFCC gas turbine combustor liners will allow inlet temperatures to be increased without additional cooling, decreasing NO_x emissions.
- CFCC interstage seals will have a much lower thermal expansion than metals and therefore be designed to maintain a tighter seal.
- CFCC pipe hangers for petroleum refining will have decreased deformation at the process temperatures and increased resistance to oxidation and corrosion, resulting in downtime reductions.
- CFCC containment shells for canned motor seal-less pumps will eliminate eddy current losses and drag since the CFCC is not electrically conductive. The material will also provide for greater corrosion resistance and will reduce the risk of hazardous spill in the chemical, refining, and forest products industries.

Challenges

Some of the challenges facing the Dow Corning team include:

- Understanding the long-term, high-temperature durability of CFCCs
- Cost-effective raw materials and processing
- Ability to fabricate impermeable CFCC structures

Team Members

Dow Corning Corporation
Midland, MI

Chevron Research & Technology Center
Richmond, CA

Kaiser Compositek
Brea, CA

Office of Industrial Technologies
Washington, DC

Solar Turbines, Incorporated
San Diego, CA

Representative CFCC components for industrial applications fabricated by PIP processing.

Sundstrand Aerospace
Rockford, IL

Sundstrand Fluid Handing
Arvarda, CO

Synterials
Herndon, VA

Team Contact

Andy Szweda
Dow Corning Corporation
P.O. Box 995, MS 500
Midland, MI 48686-0995
(517) 496-4558

Continuous Fiber Ceramic Composite Program

A 10-year joint R&D effort initiated in 1992 to develop processing methods to produce reliable and cost-effective CFCC components for industrial applications.

CFCCs are light, strong, and corrosion-resistant materials capable of performing at high temperatures.

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