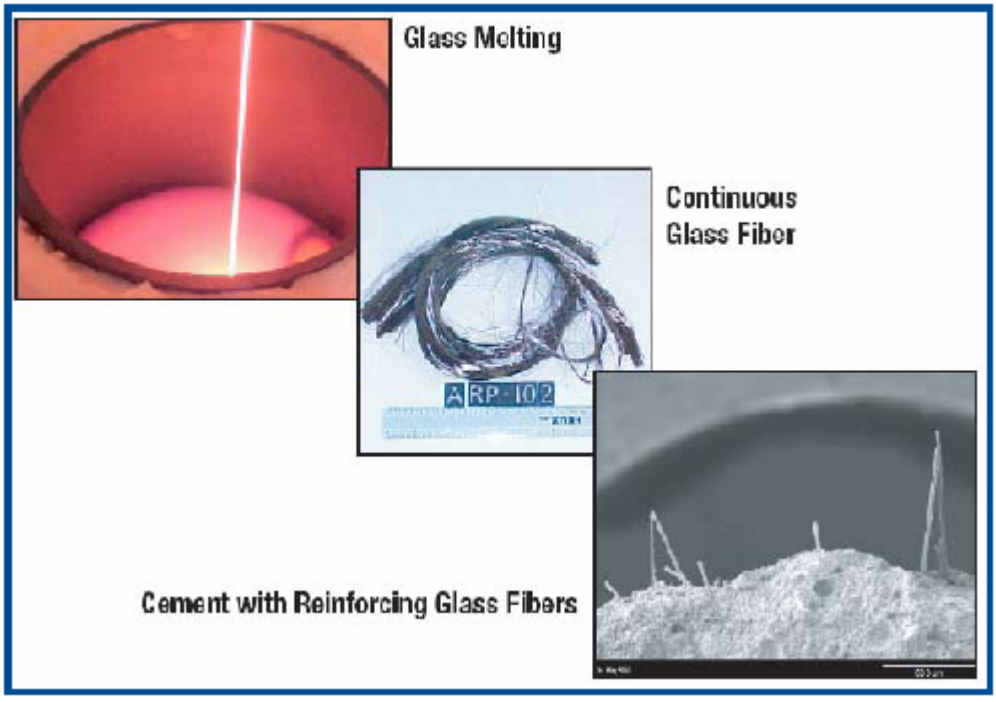
Use of High-Strength, High Alkaline-Resistant Iron-Phosphate Glass Fibers as Concrete Reinforcement

New Glass-Fiber Reinforcement Materials Provide Applications With Improved Properties

Alkali resistance is one of the important issues in concrete that is reinforced with steel or glass. The extended exposure of existing steel-reinforced and glass-fiber-reinforced concrete (GFRC) to natural weather conditions resulted in degradation of its tensile strength, flexure strength, and ductility. In addition, exposure of GFRC to normal weathering cycles of moisture and temperature resulted in cyclical volumetric changes which needed to be accounted for in the design. There have also been many attempts to modify the surface of silica fibers used in GFRC with special coatings in order to improve its alkali resistance, but these had limited success.

When compared to silica fibers, iron-phosphate glass fibers had been shown to possess improved chemical durability, mechanical strength, resistance to acid and alkali environments, and resistance to dissolution under high pH. In this project, new compositions of iron-phosphate glass fibers were developed and evaluated for reinforcing concrete.



Iron-phosphate glass fibers can be produced using conventional processing techniques.

Benefits for Our Nation and Our Industry

The development of new alkali-resistant iron-phosphate reinforcement materials resulted in energy benefits through lower energy usage in processing when compared to silica glass fibers, and extended furnace life through reduced process temperatures and melting times required for the processing of phosphate glasses. Economic benefits included lower raw material costs and development of a variety of new applications.

Applications in Our Nation's Industry

The development of new glass fibers resulted in the application across many industries including use in infrastructure, power generation, chemical processing, and insulation.

Project Description

The goal of this project was to develop and evaluate selected iron-phosphate glass fiber compositions for the reinforcement of concrete.

Barriers

Barriers addressed:

- Lack of knowledge of the effect of fiber composition, the degree of fiber loading, and resultant properties on reinforced materials;
- Lack of information on the processing of the iron-phosphate glass fiber-reinforced materials; and
- Insufficient information available on both the short-term and the long-term stability of these types of composites.

Pathways

The objectives of the project were achieved through (1) modifying the composition of the phosphate fibers by incorporating other constituents, including Al_2O; (2) evaluating the long-term durability of existing and new composite systems using both natural aging and accelerated aging techniques; (3) evaluating the stability of the proportional elastic limit of fully aged composites under cyclic environmental conditions including wetting, drying, and changes in temperature; and (4) identifying composites having improved properties when compared to those of existing composites.

Results

- Evaluated the chemical durability of currently existing iron-phosphate glass fibers in high pH
- Identified new and optimized compositions of glass fibers
- Prepared glass fibers of the new compositions using conventional melting procedures
- Evaluated the mechanical and chemical resistance of fibers and composites
- Developed alternative applications for glass fibers

Commercialization

Mo-Sci Corporation had expertise in the manufacture and testing of glass fibers. The new compositions developed in this project were produced with existing facilities and were made available for a variety of industrial applications.

The glass fibers were tailored to provide good chemical resistance to different corrosive environments which will find use in the following applications: reinforcement of special Mg-phosphate cements for nuclear reactors; acid resistance-applications, most notably, hot gas filtration (bag houses) in coal fired generators; battery separators; lower-cost substitutions for commercial E-glass for specialty corrosion resistant applications; and other, similar applications.

Project Partners

Mo-Sci Corporation
Rolla, MO
(Mariano Velez: mvelez@mo-sci.com)

Advanced Glass Yarns
Aiken, SC

University of Missouri—Rolla
Ceramic Engineering Department Center for Infrastructure Engineering Studies
Rolla, MO

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

Ending FY07
September 2007