Hollow Graphite Fibers

A Novel and New Ultra-Lightweight Reinforcement for Producing Low Mass Optical Systems

Phase II SBIR Contract NAS8-00199
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MER Corporation

- Materials and Electrochemical Research Corporation is devoted to high-technology materials and electrochemical research with emphasis on advanced composites, powders, coatings and fullerenes as well as energy conversion systems such as batteries, fuel cells and gas storage.

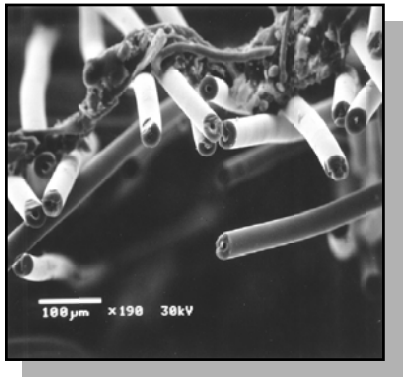
- MER's primary core technologies
  - COMPOSITES metal & ceramic matrix & carbon-carbon
  - ADVANCED POWDERS small size spherical and nanoparticles
  - ELECTROCHEMICAL SYSTEMS batteries & fuel cells
  - FULLERENES & fullerene products
  - COATINGS for parts & fibers & coating systems
  - REINFORCEMENTS ceramic fibers & coated fibers

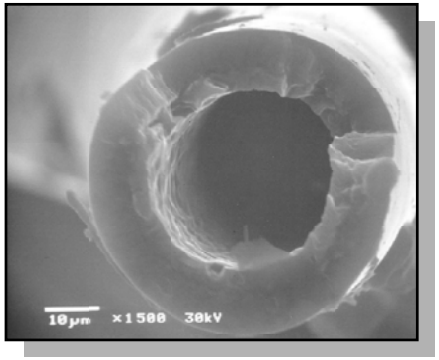
SBIR Program Objectives

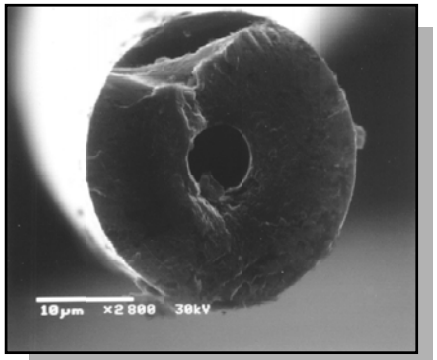
- Develop new materials to reduce optical system mass
- Develop process to produce hollow isotropic carbon fibers
- Use hollow fibers in composites to reduce weight by 25% – 50%
- Use hollow fibers to produce composites for optical, structural optical, and structural components
- Prepare carbon-carbon (C-C) composites with a functionally graded surface to SiC/SiC
  - 8 cm sample mirror; 0.5 m test mirror with 20 m radius
- Characterize composites (polymer and carbon matrix) using hollow isotropic carbon fiber to define structural and optical potential

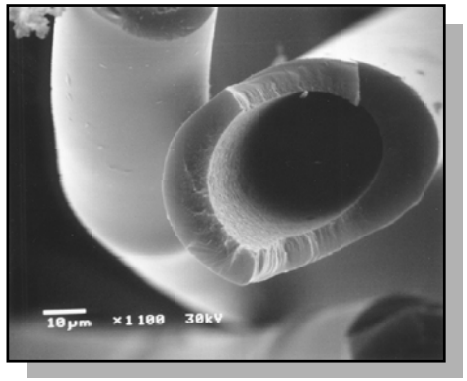
Phase I (12/99–6/00)

Phase I SBIR program demonstrated feasibility of producing hollow isotropic carbon fibers









Phase I (12/99–6/00)

- Fiber produced with strengths up to 4.2 GPa (6.1E5 psi)
- Carbon-carbon composites produced with hollow isotropic fiber compared favorably with standard commercial anisotropic carbon fiber composites as follows:

	Hollow Fiber Composite	P30X Commercial Fiber Composite
Composite Density	1.15 g/cc	1.68 g/cc
Composite Strength	149 MPa	160 MPa
Strength/Wt. Ratio	130	95

Phase II (1/01–1/03)

- Different precursors being investigated and evaluated
- Quantities of isotropic and anisotropic fibers being produced

Multi-strand hollow fiber spinner development hardware

Phase II (1/01–1/03)

- Fiber strengths of 1.2 GPa to 2.8 GPa being achieved
- Weight savings of 25% to 41% over solid fibers achieved
- Composite panels fabricated to verify mechanical properties – results are very competitive with solid fiber composite panels
- Flexural strength determined by load testing
  - Hollow-fiber panels: 32% fiber by volume; 122 MPa strength
  - Solid-fiber panels: 60% fiber by volume; 100 MPa strength
- CTE testing underway to compare solid-fiber vs. hollow-fiber composites
- Investigating use of nanotubes in walls of hollow fibers
- Nanotubes doubled the strength of hollow fibers in one test

Phase II (1/01–1/03)

- Developing materials and techniques for making mirrors
  - C-C structure using both solid and hollow fibers
  - Chemical Vapor Reaction process to convert C-C to SiC
  - Optical surface coating and polishing techniques
- Will deliver 8 cm and 0.5 m diameter hollow-fiber mirrors
- MSFC plans to run same tests on the 0.5 m hollow-fiber mirror as those run on the 0.5 m AMSD mirrors