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NASA TECH BRIEF

Lewis Research Center

High-Strength Large-Diameter Carbon-Base Fibers

Large-diameter (0.005 to 0.025 cm) high-strength carbon-base monofilaments have been prepared by the pyrolytic vapor-phase deposition of carbon (or codeposition of carbon and boron) onto a carbon-fiber substrate. The new material is primarily applicable as a reinforcement for metal-matrix composites.

Although conventional carbon yarns, consisting of small diameter (0.0008 cm) multifibers, can effectively reinforce resin-type matrix composites, such yarns have very limited use in metal-matrix composites because they are degraded by chemical reaction with the matrix material. When the conventional fibers are coated to reduce this degradation, other problems arise.

The diameters of the new fibers are large enough to permit the use of a conventional lay-up type of fabrication and the application of sufficiently thick protective coatings, without reducing the effective fiber content. The monofilament form allows the use of state-of-the-art fabrication techniques for metal-matrix composite reinforcements such as boron and silicon carbide. The development effort for these large-diameter, carbon-base monofilaments has been primarily in the 0.008 to 0.016 cm diameter range.

The process is conducted by passing a carbon filament substrate (0.0005 cm diam.) through a chemical vapor-deposition chamber at nominal velocities of 15 to 46 cm/min (0.5 to 1.5 ft/min) and a temperature of at least 1073 K (1073 to 2473 K range). The atmosphere within the chamber contains a hydrocarbon gas such as the alkane or alkene series, with or without additions of a boron-containing gas. If only a hydrocarbon gas is used, monofilaments having an ultimate tensile strength (UTS) of approximately 1.03 GN/m^2 (150,000 psi) are easily produced from substrate filaments with an initial UTS of approximately 689 MN/m^2 (100,000 psi). If the atmosphere also includes a boron-containing gas, fibers having a UTS of approximately 3.4 GN/m^2 (500,000 psi) are possible. With such high tensile strength and modulus of elasticity values of 241 GN/m^2, these large-diameter, carbon-base fibers represent a considerable improvement over conventional carbon-base yarns.

The carbon-base monifilaments are also better than conventional boron filaments on a specific-strength basis. Carbon-base monofilaments retain their desirable properties at elevated temperatures, whereas boron filaments show a catastrophic reduction in strength and in other properties, at temperatures above 1030 K.

Metal-matrix composites containing these new large diameter, carbon-base monofilaments offer the advantages of superior strength at elevated temperatures and very low density (0.19 kg/m^3). They therefore should prove useful in high-temperature equipment where component weight must be minimized.

Notes:

1. The following documentation may be obtained from:

   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.95)

   Reference:
   NASA-CR-72770 (N71-17328), Development of Manufacturing Process for Large-Diameter Carbon-Base Monofilaments by

(continued overleaf)

Chemical Vapor Deposition

2. Technical questions may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B71-10403

Patent status:

No patent action is contemplated by NASA.

Source: R. L. Hough of
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