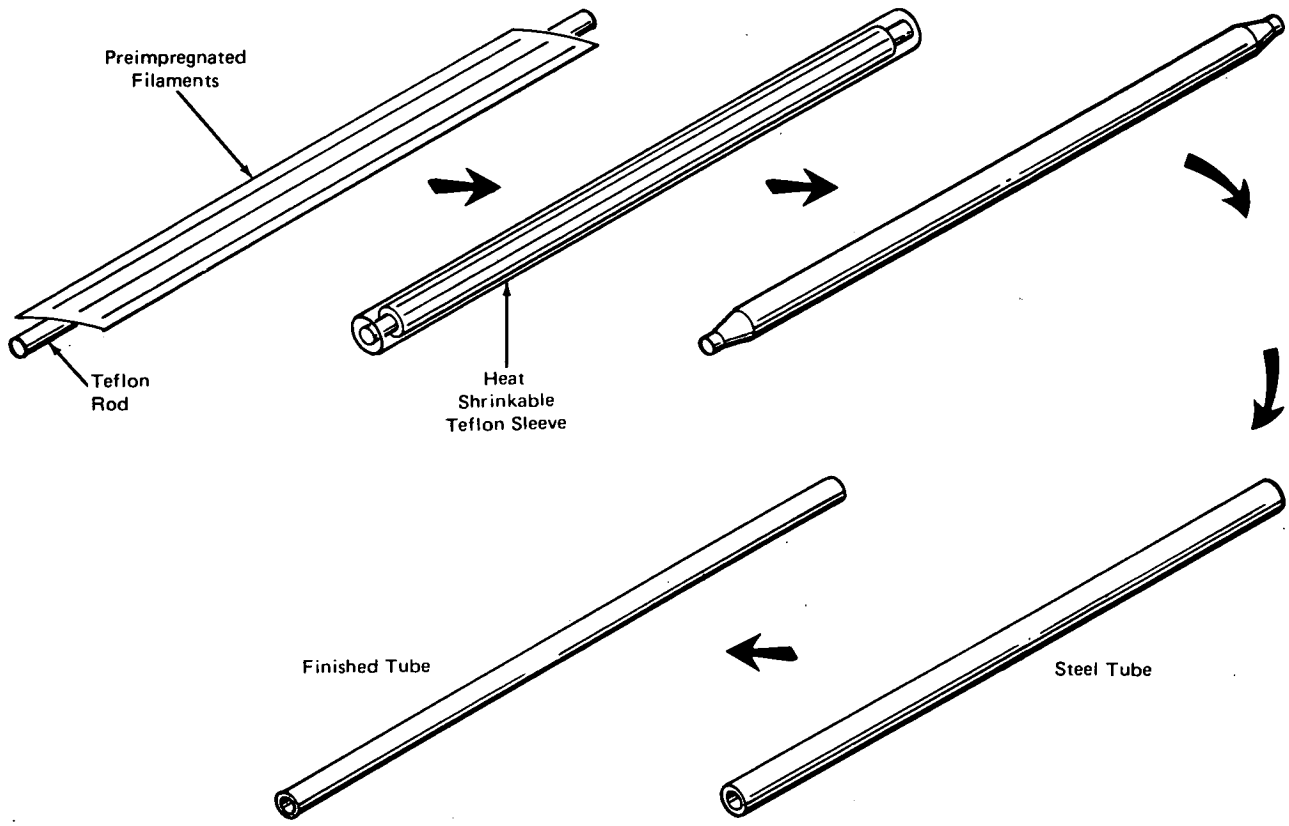
NASA TECH BRIEF

Langley Research Center

Fabrication of Uniaxial Filament-Reinforced Epoxy Tubes for Structural Application



The high strength, high stiffness, and low density of filament-reinforced composite materials have stimulated considerable interest in their potential application to aerospace structures. During the course of research on composite materials, a unique process was developed for fabricating uniaxial filament-reinforced epoxy tubes of suitable quality for structural application.

The diagram illustrates the process. Strips of pre-impregnated tape (a single ply of uniaxial filaments, rovings, or yarns embedded in a viscous epoxy resin) are cut and aligned on a Teflon rod which serves as a removable mandrel. Care is taken to align the filaments parallel to the longitudinal axis of the mandrel. The width of each strip is equal to the circumference of the tube, and plies are added until the desired wall thickness is obtained. In the second step, a heat-shrinkable Teflon sleeve is slipped over the mandrel and tape. The diameter of the Teflon sleeve should be just large enough to permit the sleeve to be slipped over the tape without damaging the outer ply. The third step consists of heating the Teflon sleeve with air from an electric heat gun. Complete shrinkage occurs at exposure to temperatures of 177°C (350°F) with partial shrinkage occuring at temperatures as low as 93°C (200°F). As the sleeve

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shrinks tightly on the composite material, air entrapped between the plies is squeezed out the end of the sleeve. In addition, the Teflon sleeve serves as a mold which forms a smooth outer surface on the filament-reinforced tube. In step four, the entire assembly is inserted in a close-fitting steel tube which prevents the mandrel from sagging while the epoxy resin is cured at an elevated temperature. The steel tube and assembly are heated in a circulating-air oven for the final epoxy cure. In step five, the assembly is removed from the steel tube, the Teflon sleeve is peeled from the outer surface of the tube, and the Teflon mandrel extracted.

Tubes fabricated by this process have several advantages. They have very smooth inner and outer surfaces which are the result of molding against Teflon surfaces. The dimensional variation is less than the tolerances set for extruded aluminum tubing. The results of void content determinations indicate that composites are essentially void-free. Compressive and column buckling tests show that boron-epoxy tubes fabricated using the process described herein weigh approximately one-half as much as aluminum tubes designed for the same loadings.

Note:

Requests for further information may be directed to:

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Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to:

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