



## A Method of Strengthening Composite/Metal Joints

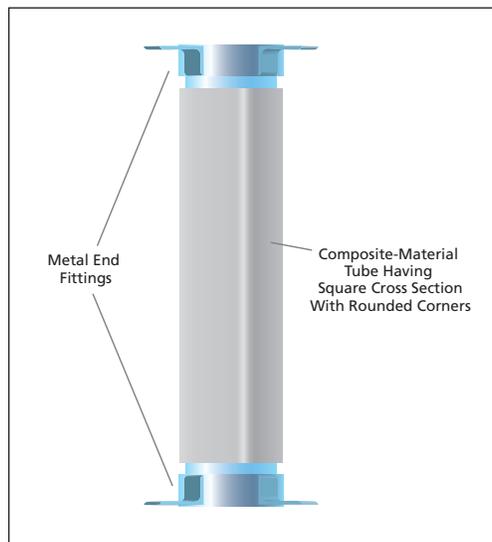
**This method is a less-expensive, easier alternative to a prior method.**

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The term “tape setback method” denotes a method of designing and fabricating bonded joints between (1) box beams or other structural members made of laminated composite (matrix/fiber) materials and (2) metal end fittings used to fasten these structural members to other structural members. The basic idea of the tape setback method is to mask the bonded interface between the metallic end fitting and composite member such that the bond does not extend out to the free edges of the composite member.

The purpose served by the tape setback method is to strengthen the joints by decoupling stress concentrations from edge defects, which can cause premature failures. A related prior method that serves a similar purpose, involving the use of tapered adherends at the joints, can be too difficult and costly to be acceptable in some applications. The tape setback method offers an easier, less costly alternative. The structural

members to which the method was originally applied were box beams in the form of composite tubes having flat faces with rounded corners. The end



A Composite-Material Box Beam with metal end fittings, shown here not to scale, is representative of the structural members on which the tape setback method was demonstrated.

fittings were plugs made of a low-thermal-expansion nickel/iron alloy (see figure). In computational-simulation studies of tensile and compressive loading of members without tape setback, stresses were found to be concentrated at the free end edges of the composite tubes, and inspection of members that had been subjected to real tension and compression tests showed that cracks started at the free end edges.

As applied to these members, the tape setback method makes them less vulnerable to initiation of failure at edge defects produced during fabrication. In real tension tests of comparable members without and with tape setback, the average mean tensile strength of the members with tape setback was found to be 1.9 times that of the members without tape setback.

*This work was done by Daniel L. Polis of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-15506-1*

## Pre-Finishing of SiC for Optical Applications

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A method is based on two unique processing steps that are both based on deterministic machining processes using a single-point diamond turning (SPDT) machine. In the first step, a high-MRR (material removal rate) process is used to machine the part within several microns of the final geometry. In the second step, a low-MRR process is used to machine the part to near optical quality using a novel ductile regime machining (DRM) process.

DRM is a deterministic machining process associated with conditions under high hydrostatic pressures and very small depths of cut. Under such conditions, using high negative-rake angle cutting tools, the high-pressure region near the

tool corresponds to a plastic zone, where even a brittle material will behave in a ductile manner.

In the high-MRR processing step, the objective is to remove material with a sufficiently high rate such that the process is economical, without inducing large-scale subsurface damage. A laser-assisted machining approach was evaluated whereby a CO<sub>2</sub> laser was focused in advance of the cutting tool. While CVD (chemical vapor deposition) SiC was successfully machined with this approach, the cutting forces were substantially higher than cuts at room temperature under the same machining conditions. During the experiments, the expansion of the part and the tool due to the heating was carefully accounted for. The

higher cutting forces are most likely due to a small reduction in the shear strength of the material compared with a larger increase in friction forces due to the thermal softening effect.

The key advantage is that the hybrid machine approach has the potential to achieve optical quality without the need for a separate optical finishing step. Also, this method is scalable, so one can easily progress from machining 50-mm-diameter samples to the 250-mm-diameter mirror that NASA desires.

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