Materials

Modeling of Failure for Analysis of Triaxial Braided Carbon Fiber Composites

Better understanding of triaxial braided composites will lead to improved aerospace and automotive structures.

John H. Glenn Research Center, Cleveland, Ohio

In the development of advanced aircraft-engine fan cases and containment systems, composite materials are beginning to be used due to their low weight and high strength. The design of these structures must include the capability of withstanding impact loads from a released fan blade. Relatively complex triaxially braided fiber architectures have been found to yield the best performance for the fan cases. To properly work with and design these structures, robust analytical tools are required that can be used in the design process.

A new analytical approach models triaxially braided carbon fiber composite materials within the environment of a transient dynamic finite-element code, specifically the commercially available transient dynamic finite-element code LS-DYNA. The geometry of the braided composites is approximated by a series of parallel laminated composites. The composite is modeled by using shell finite elements. The material property data are computed by examining test data from static tests on braided composites, where optical strain measurement techniques are used to examine the local strain variations within the material. These local strain data from the braided composite tests are used along with a judicious application of composite micromechanics-based methods to compute the stiffness properties of an equivalent unidirectional laminated composite required for the shell elements. The local strain data from the braided composite tests are also applied to back out strength and failure properties of the equivalent unidirectional composite. The properties utilized are geared towards the application of a continuum damage mechanics-based composite constitutive model available within LS-DYNA. The developed model can be applied to conduct impact simulations of structures composed of triaxially braided composites.

The advantage of this technology is that it facilitates the analysis of the deformation and damage response of a triaxially braided polymer matrix composite within the environment of a transient dynamic finite-element code such as LS-DYNA in a manner which accounts for the local physical mechanisms but is still computationally efficient. This methodology is tightly coupled to experimental tests on the braided composite, which ensures that the material properties have physical significance.

Aerospace or automotive companies interested in using triaxially braided composites in their structures, particularly for impact or crash applications, would find the technology useful. By the development of improved design tools, the amount of very expensive impact testing that will need to be performed can be significantly reduced.

This work was done by Robert K. Goldberg and Gary D. Roberts of Glenn Research Center and Justin D. Littell and Wieslaw K. Binienda of the University of Akron. Further information is contained in a TSP *(see page 1)*.

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18435-1.

Catalyst for Carbon Monoxide Oxidation

This catalyst forms carbon dioxide in a high-powered, pulsed CO_2 laser.

Langley Research Center, Hampton, Virginia

In many applications, it is highly desirable to operate a CO_2 laser in a sealed condition, for in an open system the laser requires a continuous flow of laser gas to remove the dissociation products that occur in the discharge zone of the laser, in order to maintain a stable power output. This adds to the operating cost of the laser, and in airborne or space applications, it also adds to the weight penalty of the laser. In a sealed CO_2 laser, a small amount of CO_2 gas is decomposed in the electrical discharge zone into corresponding quantities of CO and O_2. As the laser continues to operate, the concentration of CO_2 decreases, while the concentrations of CO and O_2 correspondingly increase. The increasing concentration of O_2 reduces laser power, because O_2 scavenges electrons in the electrical discharge, thereby causing arcing in the electric discharge and a loss of the energetic electrons required to boost CO_2 molecules to lasing energy levels. As a result, laser power decreases rapidly.

The primary object of this invention is to provide a catalyst that, by composition of matter alone, contains chemisorbed water within and upon its structure. Such bound moisture renders the catalyst highly active and very long-lived, such that only a small quantity of it needs to be used with a CO_2 laser under ambient operating conditions.

This object is achieved by a catalyst that consists essentially of about 1 to 40 percent by weight of one or more platinum group metals (Pt, Pd, Rh, Ir, Ru,