ventional process conditions, and the means by which the large amount of molten metal is introduced into the fiber preform. Modification of the low-temperature, ultraviolet-enhanced chemical vapor deposition process used to apply interface coatings to the fiber preform was also required to accommodate the high preform thickness.

The thick-section CMC processing developed in this work proved to be invaluable for component development, fabrication, and testing in two complementary efforts. In a project for the Army, involving SiC/SiC blisk development, nominally 0.8 in. thick × 8 in. diameter (≈2 cm thick × 20 cm diameter) components were successfully infiltrated. Blisk hubs were machined using diamond-embedded cutting tools and successfully spin-tested. Good ply uniformity and extremely low residual porosity (<2 percent) were achieved, the latter being far lower than that achieved with SiC matrix composites fabricated via CVI or PIP. The pyrolytic carbon/zirconium nitride interface coating optimized in this work for use on carbon fibers was incorporated in the SiC/SiC composites and yielded a >41 ksi (≈283 MPa) flexural strength.

This work was done by Jason Babcock, Gautham Ramachandran, Brian Williams, and Robert Benander of Ultramet for Marshall Space Flight Center. For more information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-32736-1.

Process for Making a Noble Metal on Tin Oxide Catalyst

This method produces an efficient, room-temperature catalyst for recombining carbon monoxide and oxygen products.

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To produce a noble metal-on-metal oxide catalyst on an inert, high-surface-area support material (that functions as a catalyst at approximately room temperature using chloride-free reagents), for use in a carbon dioxide laser, requires two steps: First, a commercially available, inert, high-surface-area support material (silica spheres) is coated with a thin layer of metal oxide, a monolayer equivalent. Very beneficial results have been obtained using nitric acid as an oxidizing agent because it leaves no residue. It is also helpful if the spheres are first de-aerated by boiling in water to allow the entire surface to be coated. A metal, such as tin, is then dissolved in the oxidizing agent/support material mixture to yield, in the case of tin, metastannic acid. Although tin has proven especially beneficial for use in a closed-cycle CO_2 laser, in general any metal with two valence states, such as most transition metals and antimony, may be used. The metastannic acid will be adsorbed onto the high-surface-area spheres, coating them. Any excess oxidizing agent is then evaporated, and the resulting metastannic acid-coated spheres are dried and calcined, whereby the metastannic acid becomes tin(IV) oxide.

The second step is accomplished by preparing an aqueous mixture of the tin(IV) oxide-coated spheres, and a soluble, chloride-free salt of at least one catalyst metal. The catalyst metal may be selected from the group consisting of platinum, palladium, ruthenium, gold, and rhodium, or other platinum group metals. Extremely beneficial results have been obtained using chloride-free salts of platinum, palladium, or a combination thereof, such as tetraammineplatinum (II) hydroxide ($[Pt(NH_3)_4](OH)_2$), or tetraamminepalladium nitrate ($[Pd(NH_3)_4](NO_3)_2$).

It is also beneficial if the coated spheres are first de-aerated by boiling. The platinum salt will be adsorbed onto the coated spheres. A chloride-free reducing agent is then added to the aqueous mixture whereby the catalyst metal is deposited on the tin(IV) oxide-coated spheres. Any reducing agent that decomposes to volatile products and water upon reaction or drying may be used. Formic acid, hydroxylamine (NH_2OH), hyrdrazine (N_2H_4), and ascorbic acid are particularly advantageous. After the metal has been deposited on the tin(IV) oxide-coated spheres, the solution is evaporated to dryness, whereby the desired noble metal-on-metal oxide catalyst is obtained.

This innovative process results in a more uniform application than other methods. Similarly, the method of forming and applying a precious metal to either tin oxide, or an inert substrate, is a one-step process and occurs at a lower temperature than that commonly used by other processes. This invention is inherently clean because excess reagents, such as nitric acid and formic acid, as well as unwanted products, such as nitrates and formates, all decompose and are removed from the system by simple evaporation without the necessity for separating them by filtration or washing.

This work was done by Patricia Davis and Irvin Miller of Langley Research Center and Billy Upchurch of Science and Technology Corporation. Further information is contained in a TSP (see page 1). ***LAR-13741-1***