

slope of 2.1 nm/V. This slope differs from slopes (2.2 and 2.77 nm/V) reported for similar prior measurements on nanotemplates made from bulk aluminum. The differences among these slopes may be attributable to differences among impurities and defects in

bulk and electron-beam-evaporated aluminum specimens.

*This work was done by Nosang Myung, Jean-Pierre Fleurial, Minhee Yun, William West, and Daniel Choi of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).*

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## Electroform/Plasma-Spray Laminates for X-Ray Optics

**Properties of lightweight components can be optimized.**

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Electroform/plasma-spray laminates have shown promise as lightweight, strong, low-thermal-expansion components for x-ray optics. The basic idea is to exploit both (1) the well-established art of fabrication of optical components by replication and (2) plasma spraying as a means of reinforcing a thin replica optic with one or more backing layer(s) having tailorable thermomechanical properties. In x-ray optics as in other applications, replication reduces the time and cost of fabrication because grinding and polishing can be limited to a few thick masters, from which many lightweight replicas can thereafter be made.

The first step in the fabrication of a component of the type in question is to make a replica optic by electroforming a thin layer of nickel on a master. Through proper control of the electro-

forming process conditions, it is possible to minimize residual stress and, hence, to minimize distortion in the replica. Next, a powder comprising ceramic particles coated with a metal compatible with the electroformed nickel is plasma-sprayed onto the backside of the nickel replica. Then through several repetitions and variations of the preceding steps or perhaps a small compressive stress, alternating layers of electroformed nickel and plasma-sprayed metal-coated ceramic powder are deposited.

The thicknesses of the layers and the composition of the metal-coated ceramic powder are chosen to optimize the strength, areal mass density, and toughness of the finished component. An important benefit of using both elec-

troforming and plasma spraying is the possibility of balancing stresses to a minimum level, which could be zero or perhaps a small net compressive stress designed to enhance the function of the component in its intended application.

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*In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:*

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*Refer to GSC-14977-1, volume and number of this NASA Tech Briefs issue, and the page number.*