

design. Thicker ribs were required along the proposed cutting/welding lines to facilitate the machining of those surfaces when the mirror was segmented. The mirror was designed to be cut into four (4) equal segments. As a result, the thicker ribs ran perpendicular to each other through the center of the mirror.

The monolithic mirror was machined and ground by closely following Materion's suggested fabrication process for AlBeMet[®], including stabilization, temperature cycling, and in-process inspection checks. Once the flatness had been obtained, the mirror was sent for nickel plating. The mirror was plated with high-phosphorous nickel to a thickness between 0.003 and 0.004 in. (≈ 0.076 and 0.102 mm) in accordance with specification AMS 2404, class I. After nickel-plating, the mirror was stabilized and then polished to obtain a finished optic. In the end, the monolithic mirror achieved a surface figure of nearly $\frac{1}{4} \lambda$ (0.286 λ) at 633 nm with a surface roughness of 15 Å rms.

The monolithic mirror was then prepared to be segmented and welded. The nickel-plating on the mirror had to be completely stripped off in order to facilitate welding. The mirror was cut into four quarters using a wire EDM process. The segments were stabilized and cleaned before being delivered to Materion for the welding process. The welds along the mirror surface were done first and the mirror flipped and aligned, and the backside, along the bottom of the ribs, was welded.

Following welding, one first had to remove enough material from the mirror surface to get below any surface damage or other irregularities caused by the weld. A small amount of material was also removed from the backside of the mirror, simply to clean up the appearance of that weld. The mirror was stress relieved before being ground to the proper flatness requirement, after which the mirror was inspected and sent out for nickel plating.

The returned mirror underwent the grinding and polishing process in the same manner as that used on the monolithic mirror. The mirror was ground and polished until it achieved a surface figure of less than 1 (at 633 nm), temperature cycled for stabilization, and then re-measured. In the end, the segmented mirror achieved a surface figure of less than 0.7 at 633 nm with a surface roughness measured at 16.5 Å. It is very probable that a better surface figure could have been achieved on the segmented mirror, but budget constraints of this Phase I project prevented further efforts.

Based on the results presented, the feasibility of creating high-performance mirrors out of welded segments of AlBeMet[®] has been proven and has the potential for being used in a full-size astronomical mirror.

This work was done by Vladimir Vudler of Hardric Laboratories, Inc. for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16165-1

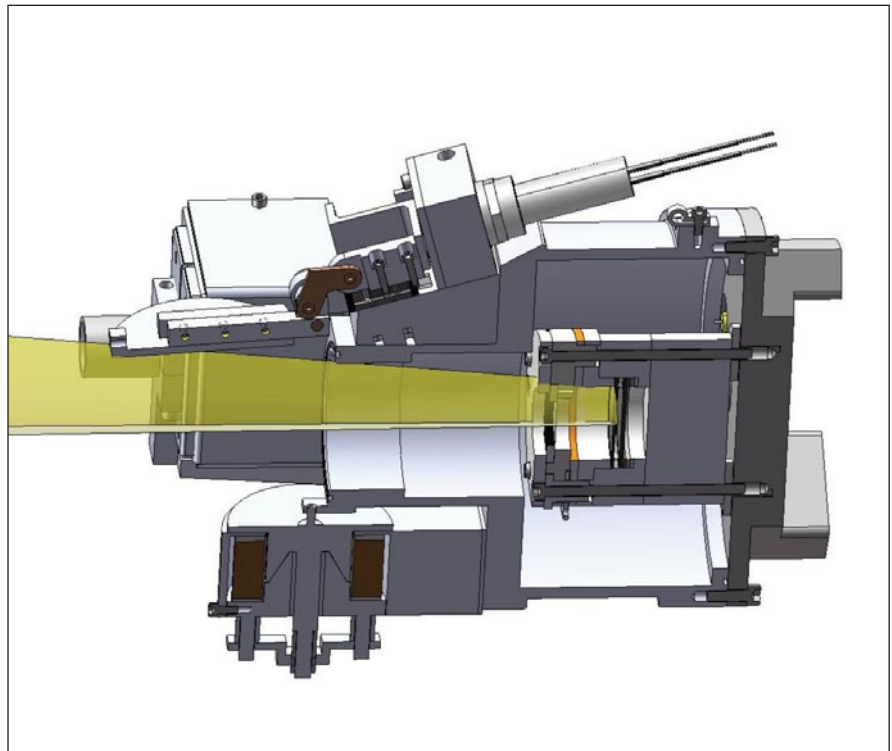
Plasma Treatment To Remove Carbon From Indium UV Filters

Hydrogen plasma cleaning is used in sterilization applications in healthcare as an alternative to autoclaving.

NASA's Jet Propulsion Laboratory, Pasadena, California

The sounding rocket experiment FIRE (Far-ultraviolet Imaging Rocket Experiment) will improve the science community's ability to image a spectral region hitherto unexplored astronomically. The imaging band of FIRE (≈ 900 to 1,100 Å) will help fill the current wavelength imaging observation hole existing from ≈ 620 Å to the GALEX band near 1,350 Å. FIRE is a single-optic prime focus telescope with a 1.75-m focal length. The bandpass of 900 to 1100 Å is set by a combination of the mirror coating, the indium filter in front of the detector, and the salt coating on the front of the detector's microchannel plates. Critical to this is the indium filter that must reduce the flux from Lyman-alpha at 1,216 Å by a minimum factor of 10^{-4} . The cost of this Lyman-alpha removal is that the filter is not fully transparent at the desired wavelengths of 900 to 1,100 Å.

Recently, in a project to improve the performance of optical and solar blind detectors, JPL developed a plasma process capable of removing carbon contamination from indium metal. In this work, a low-power, low-temperature



A cutaway view shows the **Detector Assembly and Filter**. The indium filter sits just in front of the detector plates in the light beam (yellow cone) at the orange ring.

hydrogen plasma reacts with the carbon contaminants in the indium to form methane, but leaves the indium metal surface undisturbed. This process was recently tested in a proof-of-concept experiment with a filter provided by the University of Colorado. This initial test on a test filter showed improvement in transmission from 7 to 9 percent near 900 Å with no process optimization applied. Further improvements in this performance were readily achieved to bring the total transmission to 12% with optimization to JPL's existing process.

A low-power, hydrogen plasma treatment is generated in a PlasmaTherm RIE etcher using a mixture of argon and hy-

drogen gas. The gas ratio is optimized in order to control the following variables: bias voltage, atomic hydrogen content, and substrate temperature. Low bias voltage is required to avoid mechanically degrading the filters by sputtering the indium foil. High atomic hydrogen content is required to enhance the carbon removal rate. Low substrate temperature is required to avoid deformation of the indium foil due to sagging. Those variables are optimized around MFC (mass flow controller) setpoints of 25 sccm argon and 7 sccm hydrogen.

This work was done by Harold F. Greer and Shouleh Nikzad of Caltech, and Matthew Beasley and Brennan Gantner of the Univer-

sity of Colorado for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

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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