Manufacturing & Prototyping

Glass Solder Approach for Robust, Low-Loss, Fiber-to-Waveguide Coupling

Goddard Space Flight Center, Greenbelt, Maryland

The key advantages of this approach include the fact that the index of interface glass (such as Pb glass n = 1.66) greatly reduces Fresnel losses at the fiber-to-waveguide interface, resulting in lower optical losses. A contiguous structure cannot be misaligned and readily lends itself for use on aircraft or space operation. The epoxy-free, fiber-to-waveguide interface provides an optically pure, sealed interface for low-loss, high-power coupling. Proof of concept of this approach has included successful attachment of the low-melting-temperature glass to the x–y plane of the crystal, successful attachment of the low-melting-temperature glass to the end face of a standard SMF (single-mode fiber), and successful attachment of a wetted low-melting-temperature glass SMF to the end face of a KTP crystal.

There are many photonic components on the market whose performance and robustness could benefit from this coupling approach once fully developed. It can be used in a variety of fiber-coupled waveguide-based components, such as frequency conversion modules, and amplitude and phase modulators. A robust, epoxy-free, contiguous optical interface lends itself to components that require low-loss, high-optical-power handling capability, and good performance in adverse environments such as flight or space operation.

This work was done by Shirley McNeil, Philip Battle, and Todd Hawthorne of AdvR, Inc.; and John Lower, Robert Wiley, and Brett Clark of 3SAE Technologies, Inc. for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16348-1

Lightweight Metal Matrix Composite Segmented for Manufacturing High-Precision Mirrors

New approach is examined to reduce production costs.

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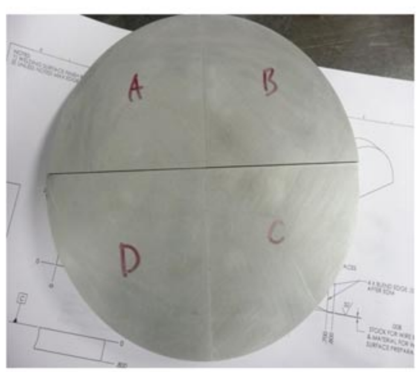
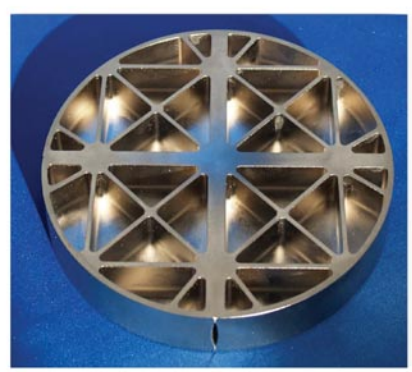
High-precision mirrors for space applications are traditionally manufactured from one piece of material, such as lightweight glass "sandwich" or beryllium. The purpose of this project was to develop and test the feasibility of a manufacturing process capable of producing mirrors out of welded segments of AlBeMet® (AM162H). AlBeMet® is a HIP'd (hot isostatic pressed) material containing approximately 62% beryllium and 38% aluminum. As a result, AlBeMet® shares many of the benefits of both of those materials for use in high performance mirrors, while minimizing many of their weaknesses.

AlBeMet® machines more like aluminum than beryllium, but retains many of the beneficial structural characteristics of beryllium, such as a lower coefficient of thermal expansion (CTE), greater stiffness, and lower density than aluminum. AlBeMet® also has as a key characteristic that it can be electron-beam welded, and AlBeMet® has been demonstrated as a suitable material for use as an optical substrate. These last two characteristics were central to the selection of AlBeMet® as the material to be used in the construction of the segmented mirror. In order to effectively compare the performance of the monolithic and the segmented mirror, a plano mirror was designed.

A plano mirror is the best design, as it minimizes the effect of extraneous factors on the performance of the final mirror, such as the skill of the polisher to achieve the proper prescription. A plano mirror will also theoretically retain the same prescription when segmented and then reassembled. Any material lost to the kerf will not change the prescription, unlike, for example, a spherical mirror whose radius of curvature will become smaller with the loss of material. The mirror design also incorporates light-weighting cavities and stiffening ribs, as is typical in space-based mirror





Front of the welded mirror substrate. **Back** of the finished mirror.