INVESTIGATION OF ZERODUR MATERIAL PROCESSING

FINAL REPORT

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Prepared for:

Optical System Branch
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Investigation of Zerodur Material Processing

The Center for Applied Optics (CA), of The University of Alabama (UAH) is pleased to submit this Final Report entitled "Investigation of Zerodur Material Processing" for NASA Contract NAS8-38609, D.O. 28. The objectives of the effort were to

* prepare glass samples by cutting, grinding, etching, and polishing block Zerodur to desired specifications using equipment located in the optical shop located in the Optical System Branch at NASA/MSFC;

* Characterize samples for subsurface damage and surface roughness;

* utilize Zerodur samples for coating investigations; and

* perform investigations into enhanced optical fabrication and metrology techniques.

The results of this investigation will be used to support the AXAF program as well as other NASA/MSFC research programs. In the following paragraphs, the results of the technical effort are presented and discussed.

A total of 42 Zerodur coating samples were fabricated for coating by various NASA vendors. The samples measured 3" x 4" x 0.75" thick. The samples were taken through a controlled grind and polish process to achieve surface roughness requirements of 5 Angstroms RMS. The samples were measured for surface roughness and figure before and after coating. These coating samples were used to help NASA scientists determine the best coating for the AXAF mirrors. The Ca WYKO Surface Profilometer was utilized for these measurements as well as the WYKO Surface Profilometer acquired by NASA's Optics Division last year.

The auto correlation and power spectrum plots reveal any periodic structure that may be present on the surface. The auto covariance plots show that there may be some periodicity on the surface of the samples. This periodic structure could effect the results of coating tests by causing scattering of high energy X-rays. Also, NASA personnel at the Optics Division have concluded that the WYKO Topo-3D does not have the spatial resolution necessary to measure the high frequency features on the coating samples. Since then, the Optics Division has acquired a WYKO Surface Profilometer with both 3D and 2D detector arrays. The 2D array does have the required resolution, so the coating samples may be re-measured in the future. These problems and issues are still open and unresolved, and more investigations may be required even though the coating samples have been completed. NASA has already decided on the coating that will be used for AXAF based on results from other performance tests performed by other organizations.

Other activities were performed to investigate fabrication techniques that could possibly enhance fabrication of AXAF samples.

* Modified a small circular diamond saw for cutting optical material. The goal was to try and achieve a precision cut and a fine surface finish. The surface finish produced by this saw is adequate, but the cutting accuracy is not as good as expected.

* To test the above diamond saw, four 2-inch diameter mirrors were cut for Space Sciences Division (SSD) such that when assembled, the four pieces form a pyramid. The results were adequate but, as stated above, not as good as expected.

* The diamond saw was further modified to try and improve cutting capability. The saw was tested by cutting MgF and

KdP crystals for SSD. The cutting accuracy is still inadequate due to the high flexibility of the saw blade.

* Three 10-inch diameter windows for SSD were resurfaced. The windows are used in a high-temperature test chamber and become highly discolored after repeated use. The purpose of this investigation was to examine the extent of the discoloration into the surface of the optical material. It was found that with a light grind with 5 micron abrasive (aluminum oxide) and repolishing, the windows were restored to high optical quality and can be re-used many times.

A fixture used to rotate an AXAF mandrel during a coating operation was designed and assembled. The mandrel was coated with evaporated gold in a chamber by NASA personnel in the Optics Division. The rotating fixture worked well and the coating operation was deemed a success by Optics Division personnel.

UAH personnel assisted in setting up various new equipment received by NASA Optics Division throughout the period of performance in order to perform this D.O. These included a WYKO 3D Profilometer, a 3-spindle polishing machine, a Bauer Surface Profiler, a 1.8-meter capacity diamond point turning machine, and a Zeiss Coordinate Measuring Machine. UAH personnel also assisted in other AXAF activities throughout the period of performance such as fabrication of related tooling in the machine shop and optics shop.

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