"SYNCHROTRON/CRYSTAL SAMPLE PREPARATION"

FINAL REPORT

JULY 1993

Prepared for:

Optical Systems Branch
NASA/Marshall Space Flight Center
Huntsville, Alabama

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Synchrotron/Crystal Sample Preparation

The Center for Applied Optics (CAO) of the University of Alabama in Huntsville (UAH), is pleased to submit this Final Report "Synchrotron/Crystal Sample Preparation" in completion of Contract NAS8-38609, Delivery Order No. 53.

UAH recognizes that Hughes Danbury Optical Systems (HDOS) is manufacturing the AXAF mirrors. These thin-walled grazing incidence, Wolter Type-1 mirrors, varying in diameter from 1.2 to 0.68 meters, must be ground and polished using state-of-the-art techniques in order to prevent undue stress due to damage or the presence of crystals and inclusions. The effect of crystals on the polishing and grinding process must also be understood. In addition, the final state of the coating for the AXAF mirrors must be well understood. This involves coating special samples of Zerodur and measuring the reflectivity of the coatings in a synchrotron system. This work is understood to extremely important to the protection of the multimillion dollar investment in the fabrication of the AXAF mirrors.

In order to gain the understanding needed on the effect of the Zerodur crystals by the grinding and polishing process, UAH prepared glass samples by cutting, grinding, etching, and polishing as required to meet specifications for witness bars for synchrotron measurements and for investigations of crystals embedded in Zerodur. UAH then characterized these samples for subsurface damage and surface roughness and figure. The effort was accomplished using equipment located in the Optical Shop of the Optical Systems Branch at NASA/MSFC and special metrology instrumentation located in the CAO Laboratories at UAH.

The activities began by UAH personnel fabricating 170 pieces of Zerodur break-test samples. These samples were 60mm dia. x 6mm thick. They were prepared by grinding and polishing 7 blocks using a prescribed material removal rate with five grit sizes. The material removal rates were as follows:

30 micron - .004" minimum
20 micron - .0022" minimum
12 micron - .0010" minimum
5 micron - .0007" minimum
3 micron - .0001" minimum (polish)

The grinding lap consisted of ceramic tiles which were waxed to a case iron plate. A pressure of 0.5 lbs./sq. inch of tile area was applied while grinding. The polishing lap was made of a plastic sheet material that was glued to an aluminum plate. A pressure of 0.25 lbs./sq. inch of plastic sheet material area was applied while polishing.

In November 1992, the tooling preparation was started for the synchrotron bars. Equipment needed for the testing and polishing of the synchrotron bars was set-up and adjusted for readiness. UAH personnel readily gained experience and knowledge in the correct procedure for testing surface roughness of synchrotron bar surfaces using the surface profilometer. During this period, the continuous polisher, which was used to attain final

flatness and surface quality of the bars, was prepared.

In December 1992, the fabrication of additional Zerodur break-test samples was completed. The grinding and polishing of these samples were finished by following the prescribed material removal rate presented above. The material used for the synchrotron bars was rough-cut out of a disc measuring approximately 22" diameter by 8" thick. It was determined that the pitch lap on the continuous polisher became too thin for properly polishing these samples. Blocking and grinding tooling were completed by the end of January 1993. The pitch lap for the continuous polisher was poured, shaped, and channeled. The machine and slurry systems were also thoroughly cleaned.

Approximately 300 more Zerodur break-test samples were then prepared. These samples were fabricated by following a prescribed material removal rate in order to prevent undue stress to the material, thereby replicating the expected process of the AXAF mirror.

Approximately 65 pieces were made from the synchrotron bars that were fabricated from the raw blanks that were rough-cut and dimensional sized.

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