THE MANUFACTURE OF HIGH RESOLUTION X-RAY GRAZING INCIDENCE TELESCOPES IN THE U.K.*

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Abstract. Research on materials and manufacturing methods are now aimed at producing 1 arc sec resolution X-ray telescopes.

1. Introduction

A number of X-ray telescopes have now been manufactured having resolutions of about 5 arc sec or somewhat better. With the aim of improving this resolution to the 1 arc sec level, a long-term research and development programme has been undertaken at the National Physical Laboratory, having the objective of understanding and overcoming the problems which will arise during the manufacture of high-resolution telescopes such as GRIST.

2. The Materials Problem

However refined and precise the measurement, manufacture, and assembly of the telescope may be, this aspect of the work will be of no avail if the materials employed in the mirror system are not sufficiently stable to remain within specification over a period of at least 5 years, to cover the flight, ground storage and re-flight phases. The materials must also be sufficiently chemically inert to withstand the effects of refurbishment, cleaning, re-coating and any possible atmospheric corrosion.

Batches of highly polishable materials, of U.K., U.S., and German origin having adequate thermal and mechanical characteristics to withstand the calculated heat input and stress levels to which GRIST will be subjected, have been under test since 1974 to enable ageing effects to be studied. The results obtained over this period of time eliminate some materials, mainly due to increasing surface roughening with age; the short list of candidate materials is promising, but the choice may well be influenced by the thermal environment of GRIST, which still remains to be specified.

3. The Manufacturing Approach

The mirror manufacturing problems are exacerbated by the fact that the mirrors are in the form of sectors, so that the symmetry of the complete figure of revolution is lost. Research has therefore been undertaken on the problems of forming, lapping and polishing sector Wolter optics to the tolerances required for GRIST, on 230 mm long mirrors. These mirrors are approximately one third of the length of the GRIST primary mirrors, and enough experience has been gained to indicate that the present processes could be scaled up without undue difficulty. Profile measurements made of the parabolic sector (Figure 1) are shown in Figure 2 and indicate that the deviation from the theoretical curve is below the limit of measurement of 0.1 μm for a significant proportion of the optically active part of the mirror.

Aspects of the polishing, measurement, and evaluation procedures have been discussed by Franks (1979). Although the ultimate test of the telescope will be made with X-rays, it is clear that it would be impracticable to rely on X-ray

Fig. 1. The 230 mm long parabolic sector mirror of the X-ray Solar Spectrometer Telescope.