Computer-Controlled Cylindrical Polishing Process for Large X-Ray Mirror Mandrels

Gufran S Khan[1], Mikhail Gubarev[2], Chet Speegle[3] and Brian Ramsey[2]

[1]ORAU, NASA/MSFC, [2]Space Science Office, NASA/MSFC, [3]Jacobs, NASA/MSFC

For technical review purpose

We are developing high-energy grazing incidence shell optics for hard-x-ray telescopes. The resolution of a mirror shells depends on the quality of cylindrical mandrel from which they are being replicated. Mid-spatial-frequency axial figure error is a dominant contributor in the error budget of the mandrel. This paper presents our efforts to develop a deterministic cylindrical polishing process in order to keep the mid-spatial-frequency axial figure errors to a minimum.

Simulation software is developed to model the residual surface figure errors of a mandrel due to the polishing process parameters and the tools used, as well as to compute the optical performance of the optics. The study carried out using the developed software was focused on establishing a relationship between the polishing process parameters and the mid-spatial-frequency error generation. The process parameters modeled are the speeds of the lap and the mandrel, the tool's influence function, the contour path (dwell) of the tools, their shape and the distribution of the tools on the polishing lap.

Using the inputs from the mathematical model, a mandrel having conical approximated Wolter-1 geometry, has been polished on a newly developed computer-controlled cylindrical polishing machine. The preliminary results of a series of polishing experiments demonstrate a qualitative agreement with the developed model. We report our first experimental results and discuss plans for further improvements in the polishing process. The ability to simulate the polishing process is critical to optimize the polishing process, improve the mandrel quality and significantly reduce the cost of mandrel production.

For online printing purpose

This paper presents our efforts to develop a deterministic cylindrical polishing process that keeps the mid-spatial-frequency axial figure errors to a minimum. Based on ideal polishing process, a mathematical model is developed to estimate the residual surface errors under a given set of operating parameters and polishing lap configuration. The model is used to optimize the polishing parameters as well as the polishing lap configuration. The preliminary series of polishing experiments demonstrate a qualitative agreement with the developed model. We report our first experimental results and discuss plans for further improvements in the polishing process.