Motivation

- Requirement for grazing-incidence x-ray shell optics with angular resolution of < 5 arcsec HPD.
  - Typical mirror shells fabricated to date at MSFC have HPDs in 13-15 arcsec range.
  - Achievable resolution depends on the quality of the mandrels from which the mirror shells are replicated.
  - Mid spatial-frequency range errors on the mandrel surface are currently limiting the quality of the mandrel.
- Therefore, deterministic and localised polishing of the mandrel is desirable.

Abstract

- Simulation studies on cylindrical polishing process
  - Establishing a relationship between the polishing process parameters and the generation of mid spatial-frequency error.
  - Optimization of the process (speeds, stroke, etc.) to keep the residual mid spatial-frequency error to a minimum.
  - Consideration of the polishing lap design to optimize the process in order to keep residual errors to a minimum.
- Development of a computer-controlled polishing machine.

Cylindrical polishing

- Operational parameters:
  - Axial speed of the back and forth polishing lap motion (stroke of the lap)
  - Rotational speed of the mandrel
  - Length of the stroke

- Design considerations for the polishing lap:
  - Relation between the rotational speed and the stroke length for the lap
  - Relation between the stroke length and the tool size
  - Effects of tool-to-groove ratio and distribution of the tool over the lap surface

Status of the experiment

- Salient features of the polishing machine:
  - Accommodates specimen of length from 12 to 30 inches with diameter ranging from 1.5 to 12 inches,
  - In order to keep uniform pressure distribution on the optical surface, a floating lap is used,
  - Applied pressure on the lap can be varied by the addition of weights,
  - Cog-free linear motor is employed to avoid vibration during polishing stroke,
  - Linear scale feedback system with 10µm feedback resolution,
  - Straightness of 2.5 µm in axial motion.

Conclusions

- Ability to simulate the polishing process is an important contribution to extend automation further and thus increase cost effectiveness.
- It is expected that the study will help us bring the angular resolution of the final electroformed shell optics close to the 5 arcsec HPD goal.

Literature