Battery-powered thin film deposition process for coating telescope mirrors in space

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INTRODUCTION

Coating telescope mirrors in space offers potential benefits to astrophysics. 1) Extend reflective aluminum observations down to 50-nm, 2) Change the coating in space from aluminum to silver for a “two-in-one” telescope concept, 3) Re-coat to repair a coating in space, 4) Remove dust contamination prior to coating for ultra-low scattering mirrors.

Recent developments in battery technology allow small lithium batteries to rapidly discharge large amounts of energy.

EXPERIMENT

ZeCoat built and tested a prototype battery-powered deposition (BPD) device. The single BPD unit was placed inside a 1.2-m vacuum chamber, and below an uncoated mirror substrate. A quartz crystal monitor was used to determine deposition rate. The unit was energized and aluminum deposition began a few seconds later. Approximately 2,400-Å of aluminum were deposited on the mirror substrate at a rate of ~40-Å/second and the total deposition time was 1-minute.

ZeCoat’s BPD process uses an array of hot filaments powered by batteries in small pressurized vessels. The tungsten filament carries the evaporation material by surface tension; an evaporation process that will work in zero gravity and the evaporation material may be emitted in any direction.

Simultaneously discharging batteries through individual filaments allow large areas to be uniformly coated in a few seconds.

RESULTS

Computer modeling of measured coating thickness distribution revealed that 34-cm and 23-cm source-spacing in a hexagonal pattern offer optimal thickness distribution. At 34-cm apart, a 1-m² area may be coated with (23) sources at 58-Å/second and achieve coating uniformity of +/-6 %. At 23-cm apart, a 1-m² area may be coated with (81) sources at 133-Å/second and achieve a coating uniformity of +/-3 %.

The model shows a hexagonal array of sources could rapidly coat a mirror with uniformity less than +/-3 %.

CONCLUSIONS

1. The vacuum of space offers the best possible place in the universe to manufacture a bare contamination-free aluminum coating.
2. High performance batteries may offer a simple path to coating optics in space.
3. ZeCoat has presented a preliminary experiment to demonstrate a reasonable method for coating an optic in space.

ZeCoat is currently developing a smaller, more powerful BPD source with programmable evaporation rate and a mechanical shutter.

REFERENCES

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