1. Introduction

Silicon Carbide (SiC) has been space-proven in “large satellite” programs for both optical and structural components. Uses of SiC in custom, single quantity, telescope applications is well documented in the literature but it has not been widely adopted outside of government funded projects due to cost and schedule challenges associated with mirror components.

We have developed a new process to address these issues and enable affordable, lightweight, and athermal SiC telescopes for “small satellite” and “CubeSat” applications. This is made possible by integrating internally-developed software and processes utilizing commercially accessible technologies.

2. Advantages of SiC Telescopes

SiC possesses the highest combination of specific stiffness (E/p) and thermal stability (k/α) of any optical grade material. These properties make SiC ideal for maintaining optical and mechanical performance throughout launch and in the dynamic thermal environment of low-earth orbit (LEO).

Properties that make SiC superior to traditional mirror materials include:
- High Elastic Modulus
- High Thermal Conductivity
- Low Coefficient Thermal Expansion (CTE)

3. Process Baseline

We have analyzed SiC mirror production costs associated with both our original baseline process and the enhanced process. Data was collected from mirrors ranging in diameter from 75 to 270 mm with all optical surfaces cladded with SiC by a Chemical Vapor Deposition (CVD) technique. The data was normalized by optical surface area and used to compare with the enhanced process.

4. Enhanced SiC Mirror Process

The baseline mirror fabrication process includes the steps outlined in Figure 3. The process was extensively customized to replace the commercially available algorithms with custom developed controlled force grinding and polishing specifically designed for SiC material processing.

5. Improvement in Optical Quality and Cost Achieved

Our enhanced process allows us to achieve better optical quality and reach near diffraction-limited performance of SiC telescopes.

6. Conclusion

We have obtained improvements in the fabrication process for Silicon Carbide Telescope mirrors. Optical quality enables the diffraction limited telescopes required in high performance imaging and laser communication applications.

Mirror processing cost reductions have been obtained and when combined with an all SiC telescope design enables cost effective, a-thermal and low mass telescopes well aligned with the requirements of LEO satellites.

7. References


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