Solid State Bonded CVC SiC® for Large UVOIR Telescope Mirrors and Structures

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Outline

- Introduction
- Program Overview
- Status
- Follow-on Effort
- Conclusions

Introduction

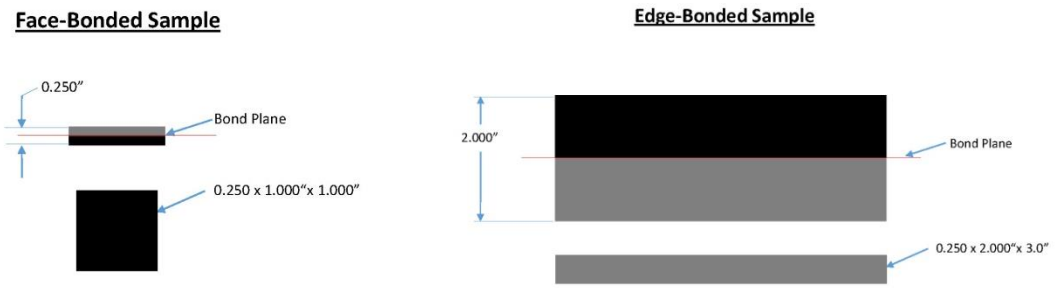
- **Trex's innovation for a type of Additive Manufacturing**
  - "Make Large Mirrors from Small Mirrors"
  - Additive manufacturing process significantly minimizes the cost and schedule of post-production fabrication steps (machining, polishing, metrology)
- **Effort addresses the need for large aperture, lightweight mirrors for future UV/Optical telescopes that will enable or enhance:**
  - Balloon-borne telescope missions
  - Discovery of habitable planets
  - Advances in solar physics
  - Study of faint structures around bright objects
- **Maturation of this technology will allow NASA and Trex to match and exceed the Chinese 4-meter monolithic silicon carbide mirror.**
- **Solid state bonded CVC SiC® components would also be used to produce components for the telescope opto-mechanical support structures.**

Program Effort

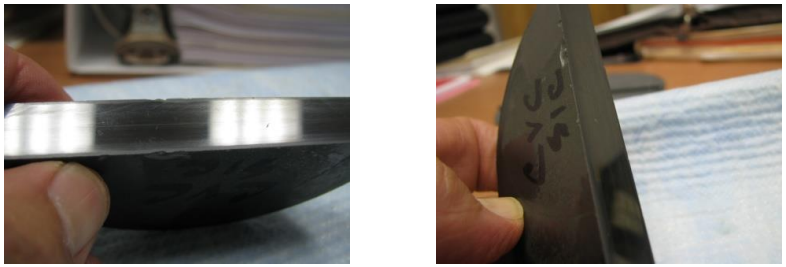
- Demonstrate a novel ceramic joining technology (solid state bonding) that would allow large mirrors and structures to be made from smaller, easily manufactured, and simply shaped components.
- Characterize the solid state bonding process for CVC SiC®.
- Optimize the bonding process for CVC SiC® with the goal of making the bond line/bond joint 100% pore-free.
- Demonstrate process scalability by manufacturing a subscale, lightweight, mirror prototype (technology demonstrator).

Program Status

- **Demonstration of solid state bonding technology**
  - Identified face- and edge-bonded sample geometries to facilitate bond line characterization and replicate meter-class lightweight mirror fabrication approach.

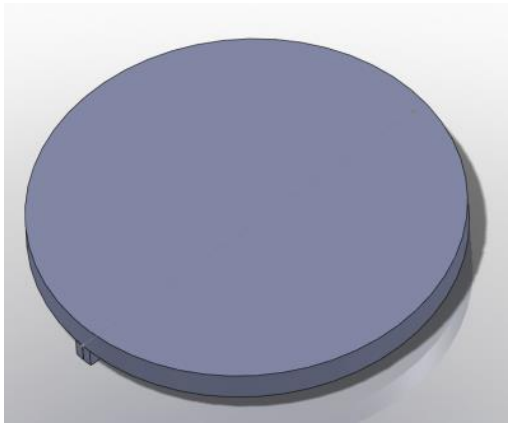


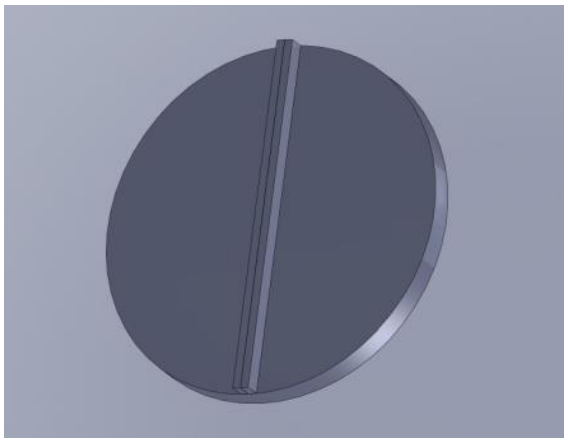
  - Defined bonding parameters
    - Identified surface finish and surface flatness as primary attributes for examination.
    - One bonded sample for each finish/flatness condition in both face- and edge-bonding configuration.
  - Early bonding demonstration on 3" diameter CVC SiC® discs.



Program Status, continued

- **Bonding sample and technology demonstrator fabrication complete.**
- **Characterization of bonding process for CVC SiC in process.**
- **Demonstration of process scalability**
  - Technology demonstrator: 5” diameter CVC SiC® bonded plano, rib-backed, specular front side polish.
  - To be compared side-by-side in thermal chamber with a 5” diameter CVC SiC® monolithic plano, rib-backed, specular front side finish.

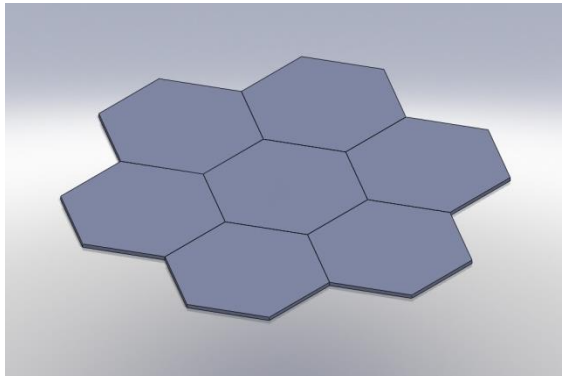




Outcome of Phase I and Proposed Phase II Effort

- **Outcome of Phase I program**
  - Demonstration and characterization of solid state bonding for CVC SiC®.

- **Proposed Phase II Effort**
  - Optimization of CVC SiC ® bonding process based on Phase I outcome.
  - Evaluation of critical material properties (strength, flexure, etc.).
  - Design and model a meter-class CVC SiC® mirror for space and balloon-borne telescopes.
  - Produce a meter-class mirror prototype.



Conclusions

- We have an additive manufacturing approach which dramatically reduces the cost for advanced optics and optical assemblies.
- Solid state bonding is a “pure” process - no bonding agents, additives, or adhesives.
- Capability to rapidly manufacturing of lightweight optics.
- Fast track to meter-class optics.