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NASA Tech Days 2013

Phase I SBIR

"Low Cost Method of Manufacturing Space Optics"

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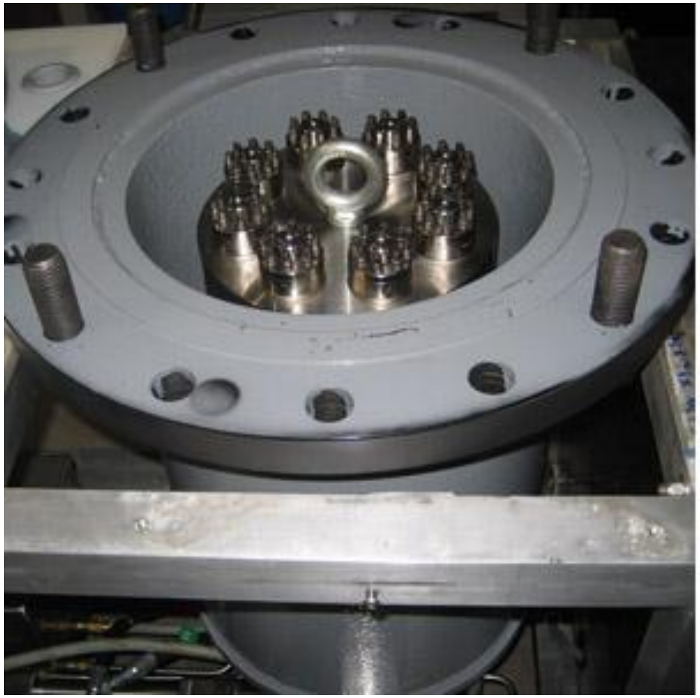
NASA POC: Ron Eng

About Ormond, LLC

- Ormond performs contract engineering and R&D
- Small business staff of engineers with unique expertise
- Work mostly related to ultra-high pressure waterjet manufacturing processes and hyperbaric testing
- Ormond conducts multiple SBIR programs with significant ongoing commercialization success

About Ormond, LLC



Ormond designs and operates test chambers at up to 120,000 psi, built custom reciprocating pumps to generate up to 200,000 psi

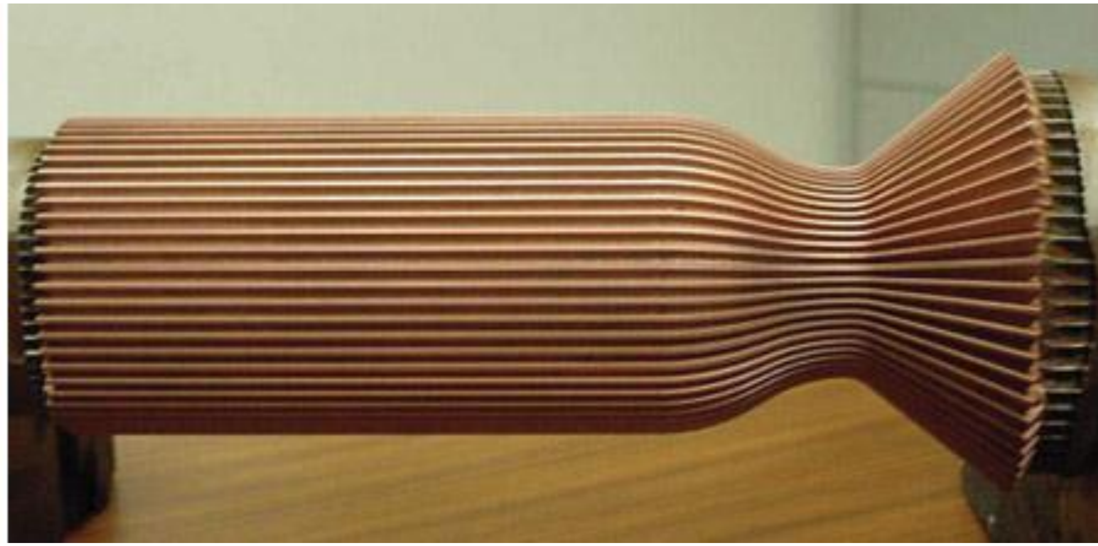
About Ormond, LLC

- Abrasivejet milling was developed at Ormond and used to manufacture Inconel X43 and X-51 Waverider scramjet flight engine cases
- This technology used to address other applications where difficult to machine metals and ceramics are involved
- Advantages in some applications include volumetric removal rate, low stress generator, able to machine thin features, machines hard and tough materials

Optics Manufacturing SBIR

- Current Phase I SBIR Contract No. NNX13CM22P
- “Low Cost Method of Manufacturing Space Optics”
- Manufacturing technology R&D; goal to increase large optics design options, significantly reduce the manufacturing time, cost and risk and to improve optics performance
- Specifically addressed are near net shaping and light weighting of glass and ceramic optical components

Ormond Milling Technology



Proprietary maskless abrasivejet milling process is used to generate complex geometries in difficult materials

Ormond Milling Technology

Gentle process is capable of milling with minimal subsurface damage or residual stress generation (CVC SiC shown)

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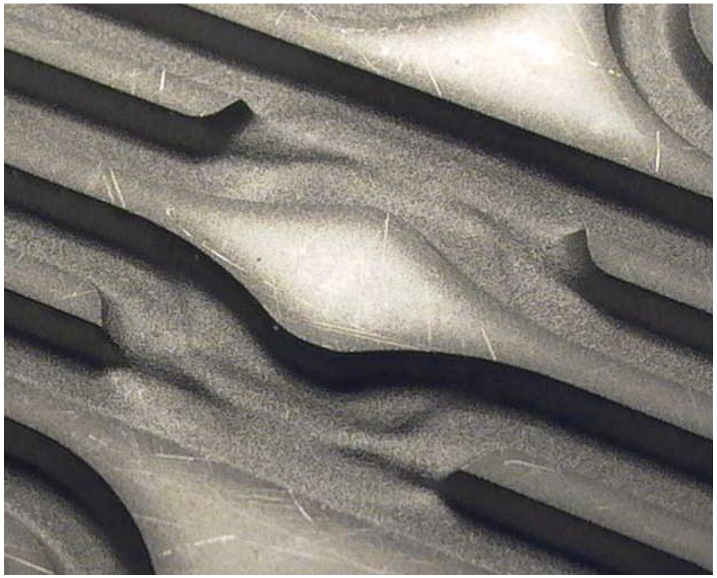
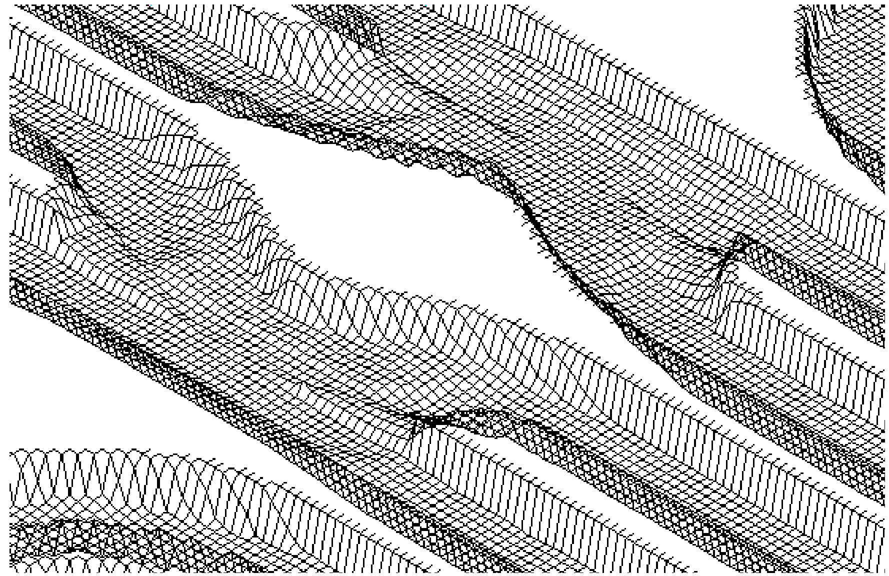
Ormond Milling Technology





Proprietary software semi-automates CNC machine code development and numerical model predicts machined geometry prior to machining test coupons

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Phase I Tasks

Milling Isogrid: Parametric Testing of mask and maskless milling methods to address current application. Full scale AMTD geometry to be delivered to NASA.

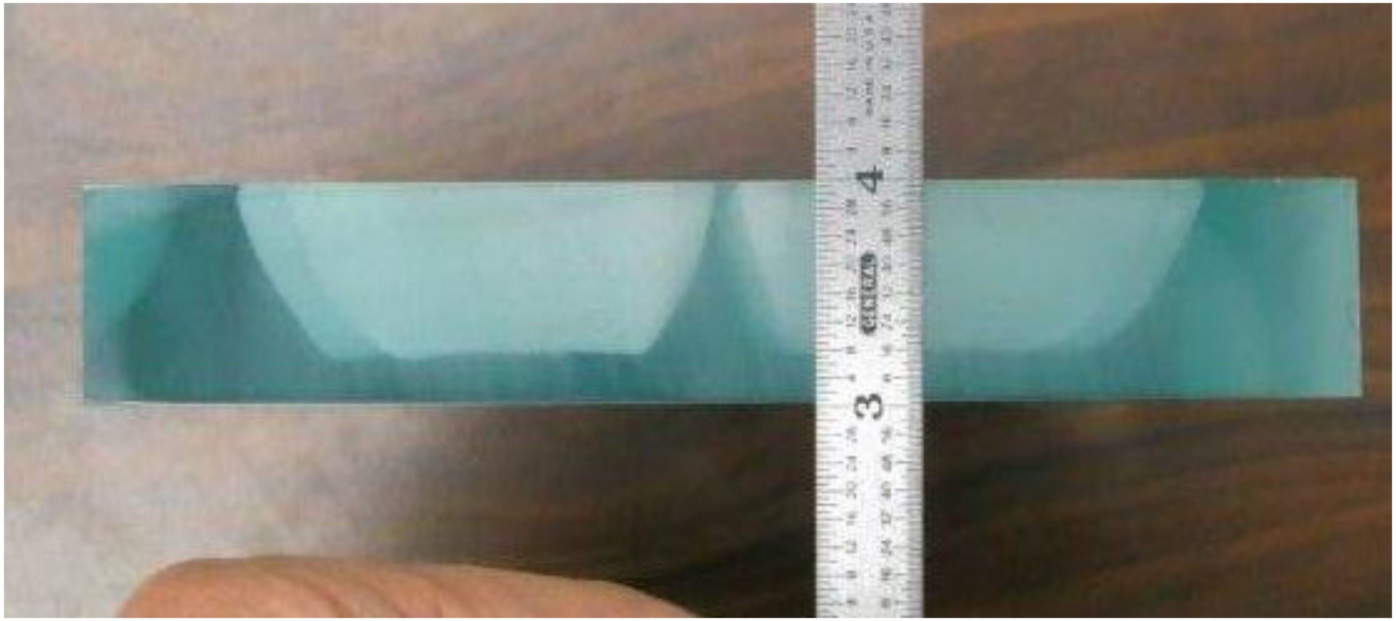
Shaping: Demonstrate rough shaping of semi-elliptical float glass coupon and present rate/cost/coupons.

Subsurface Damage Analysis: ULE and SiC coupons.

Residual Stress Analysis: ULE and SiC coupons.

Bend Coupons: Mill ULE coupons for 4-point bend MOR testing.

Phase I Progress



Initial effort involved milling using mask; proved to be very difficult to control wall taper with 0.75 inch deep pockets.

Phase I Progress

- **Maskless Milling** is performed by moving the cutting jet over the part only in the locations where machining is desired and no mask is required. This Ormond patented process requires a high level of machine control.
- Advantage is no costly expendable masking tooling. Also offers clear advantage in the flexibility to generate complex shapes.
- Key drawback is that the volumetric removal rate may be limited by the speed that the cutter can be moved before process control is lost.

Phase I Progress

Maskless Milling is now the focus: Total depth range of the 0.75 inch deep pocket is roughly 0.030 inch. The cell wall taper is now roughly 3 degrees. Will improve with additional effort.

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Phase I Completion

- Full scale demonstration coupon was delivered to NASA.
- Balance of Phase I will focus on generating quantitative data for strength, subsurface damage, residual stresses.
- Some effort to demonstrate rough milling of semi-elliptical surface.
- This work is anticipated to demonstrate technology feasibility and will lead to strong Phase II effort.

NASA SBIR/STTR Technologies

Phase I NNX13CM22P – Low Cost Method of Manufacturing Space Optics

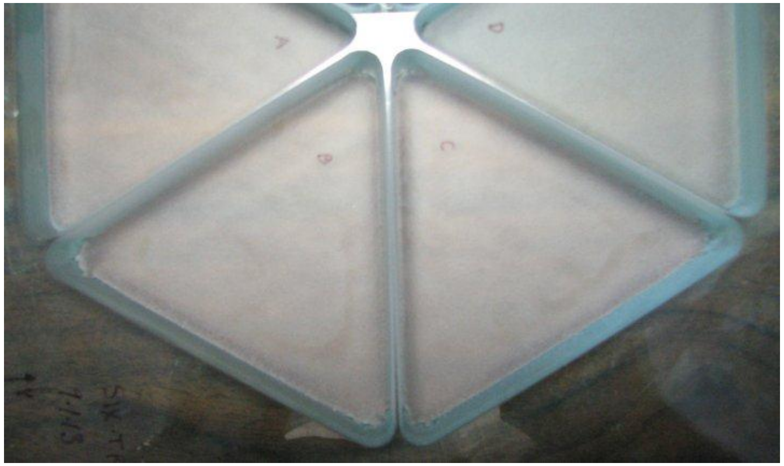
PI: Daniel G. Alberts

Ormond, LLC – Auburn, WA

Identification and Significance of Innovation

A manufacturing technology is under development to increase large optics design options, significantly reduce the manufacturing time, cost and risk involved in manufacturing large optic components and to improve optics performance. Specifically addressed are near net shaping and light weighting of glass and ceramic optical components. This gentle process is capable of milling with minimal subsurface damage or residual stress generation.

Expected TRL Range at the end of Phase I (1-9): 5



Technical Objectives and Work Plan

The primary goal of this Phase I SBIR is to demonstrate the feasibility implementing this new technology to provide significant manufacturing cost and time savings, increase design options and improve performance of large space optics. The Phase II program will result in a working system that is capable of manufacturing a 1.5 m demonstration mirror.

The Phase I scope includes milling a full scale demonstration coupon in support of AMTD and analysis of bend strength, subsurface flaws and residual stresses in milled surfaces.

NASA and Non-NASA Applications

This SBIR is being conducted in support of NASA AMTD Advanced Mirror Technology Development programs. Raytheon Space and Airborne Systems group stated that the developments made under this SBIR will directly support NASA programs including JDEM, IXO, LISA, ICESAT, ATLAST, CLARREO and ACE. Non-NASA applications include various ceramic and challenging metal milling applications, shaping armor, channel wall combustors, scramjet channel heat exchangers, etc.

Contacts

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NON-PROPRIETARY DATA