S2.03-9674 Additive Manufactured Very Light Weight Diamond Turned Aspheric Mirror

Contract No. 80NSSC18C0065 (SBIR 2018-II) (MSFC)

Mirror Technology SBIR/STTR Workshop

November 5 – 7 , 2018

Raytheon Space and Airborne Systems Event Center
2000 E. El Segundo Blvd, El Segundo, CA 90245

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OUTLINE

- CONCEPT, BACKGROUND AND GOALS
- MIRROR MFG. PROCESS
- PROGRESS TO DATE
- SUMMARY

Concept and Goals

Concept

Develop a process for producing a large ultra light weight, high performance aluminum mirror with additive manufacturing, welding and diamond turning.

Goals

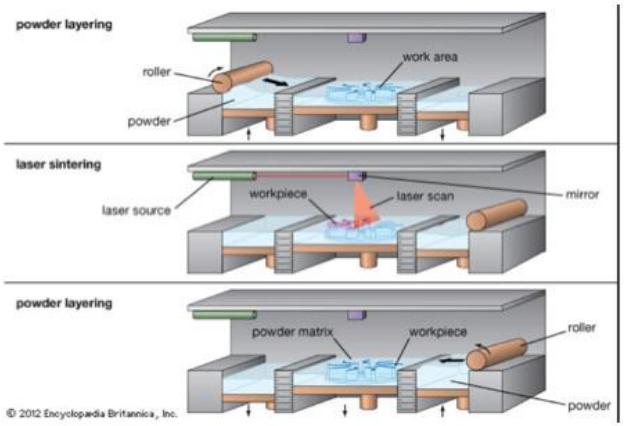
1. **Demonstration of joining hexagonal additively manufactured mirror segments with robotic welding of aluminum by laser and GTA welding processes.**

2. **Diamond turning of spherical optical contours on large welded additively manufactured mirror substrates.**

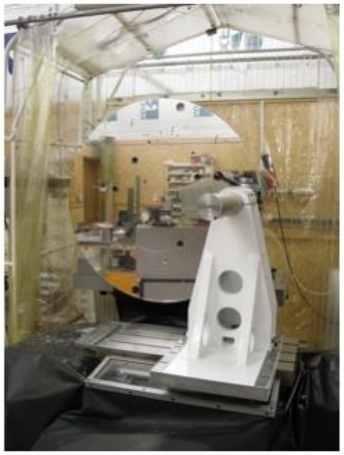
3. **Optical and dimensional inspection and characterization of the finished mirror for overall optical figure accuracy and surface smoothness achieved by diamond turning.**

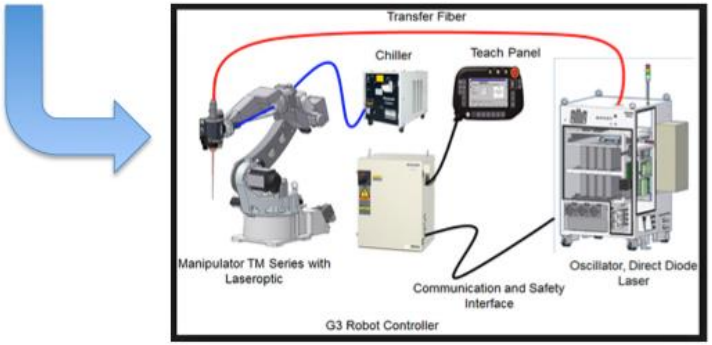
Fabricating diamond turned Al mirrors by welding hexagonal mirror segments

DMLS/SLM MFG. MIRROR



DIAMOND TURN ASPHERE





LASER/GTA WELDING MIRROR ASSEMBLY

Development Process Sequence

1. Mirror design for additive manufacturing - DOS

2. Additive Manufacturing - DOS/Stratasys

(Extensive development effort for additive process for sucessful build of complex structures.)

(Metrology and machining to prepare AM mirror substrate for welding - DOS)

3. Development of welding processes - DOS/ARC/LWS

ARC Specialties Inc., Laser Welding Solutions, Inc.

(Metallurgy, material testing, welding experiments.)

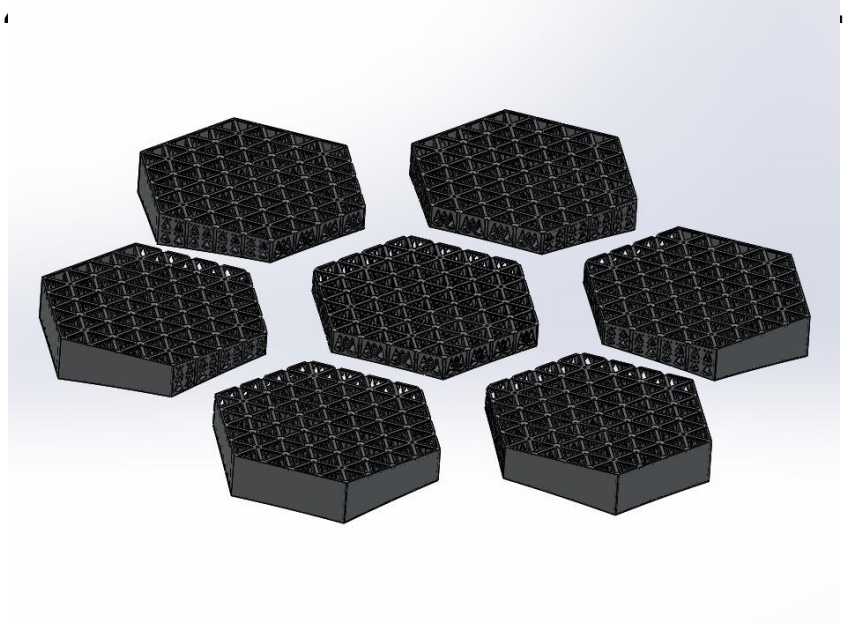
4. Diamond Turning, Metrology, Optical Testing - DOS

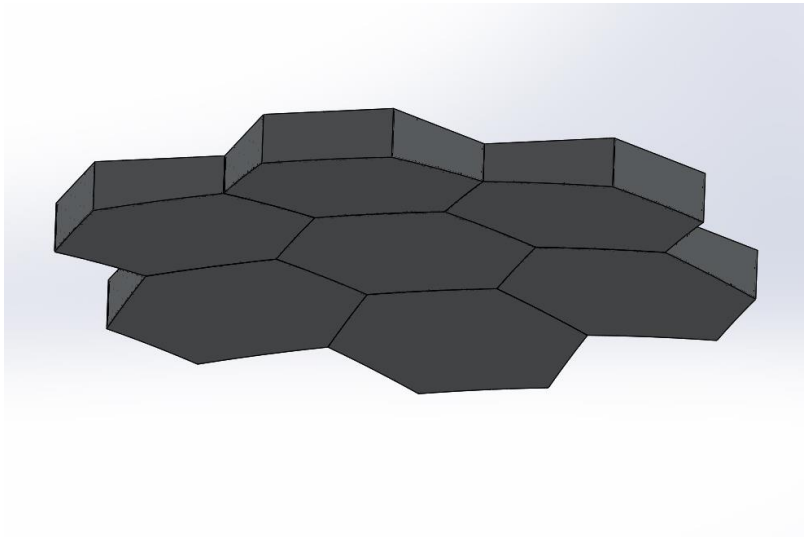
(Large Optics Diamond Turning experience and tooling.)

2.48 Meter Aluminum Mirror

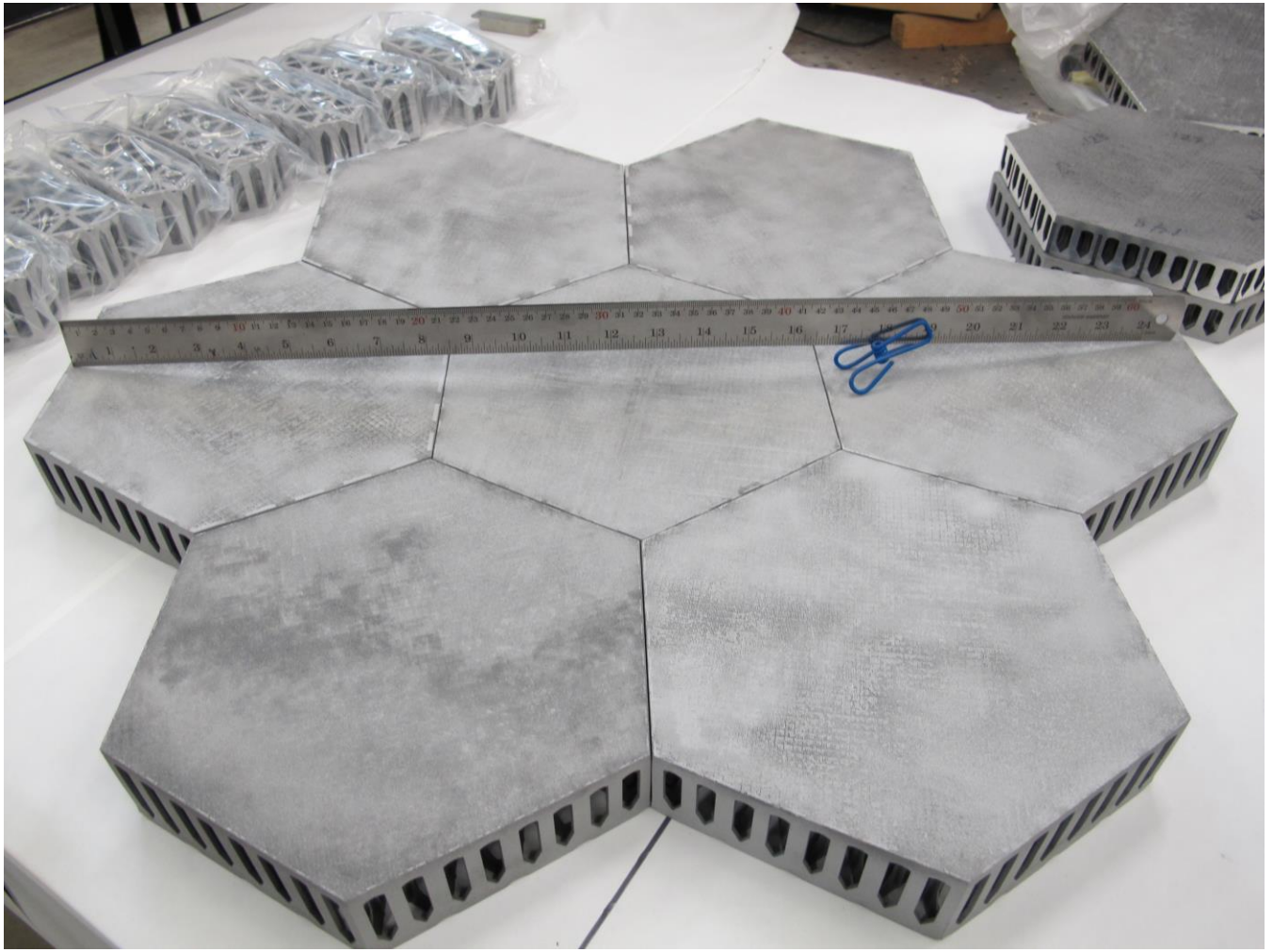
Additive Manufactured Off-Axis Contoured Mirrors Can Be Diamond Turned to Produce Segmented Mirrors of Large Size.

The largest currently available additive manufacturing machines are practically limited to about 0.4 meter diameter. Future machines are planned for up to 1 meter capacity. Deformable mirror segments are possible. Current work concerns design for fabrication and assembly of 0.

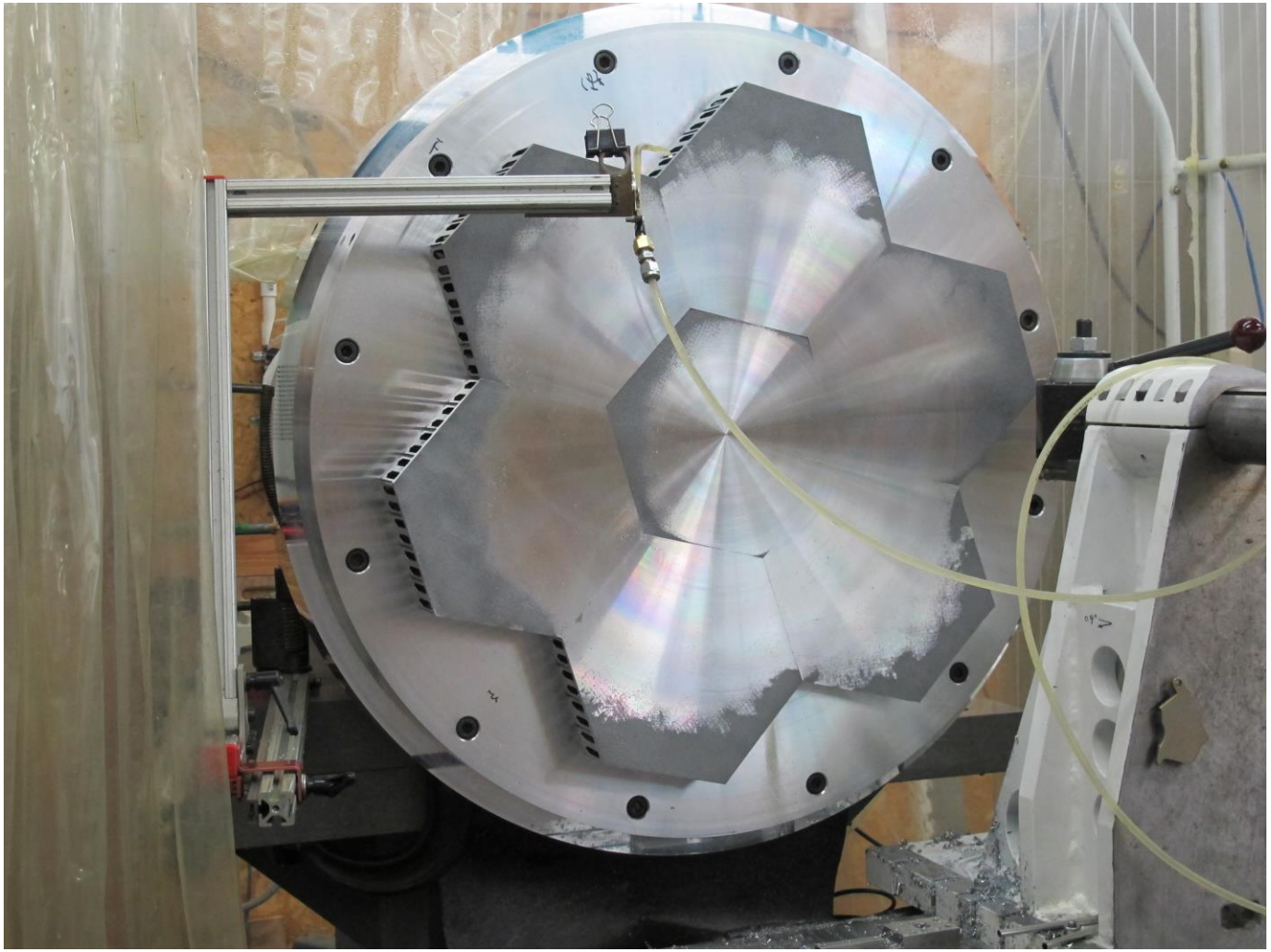




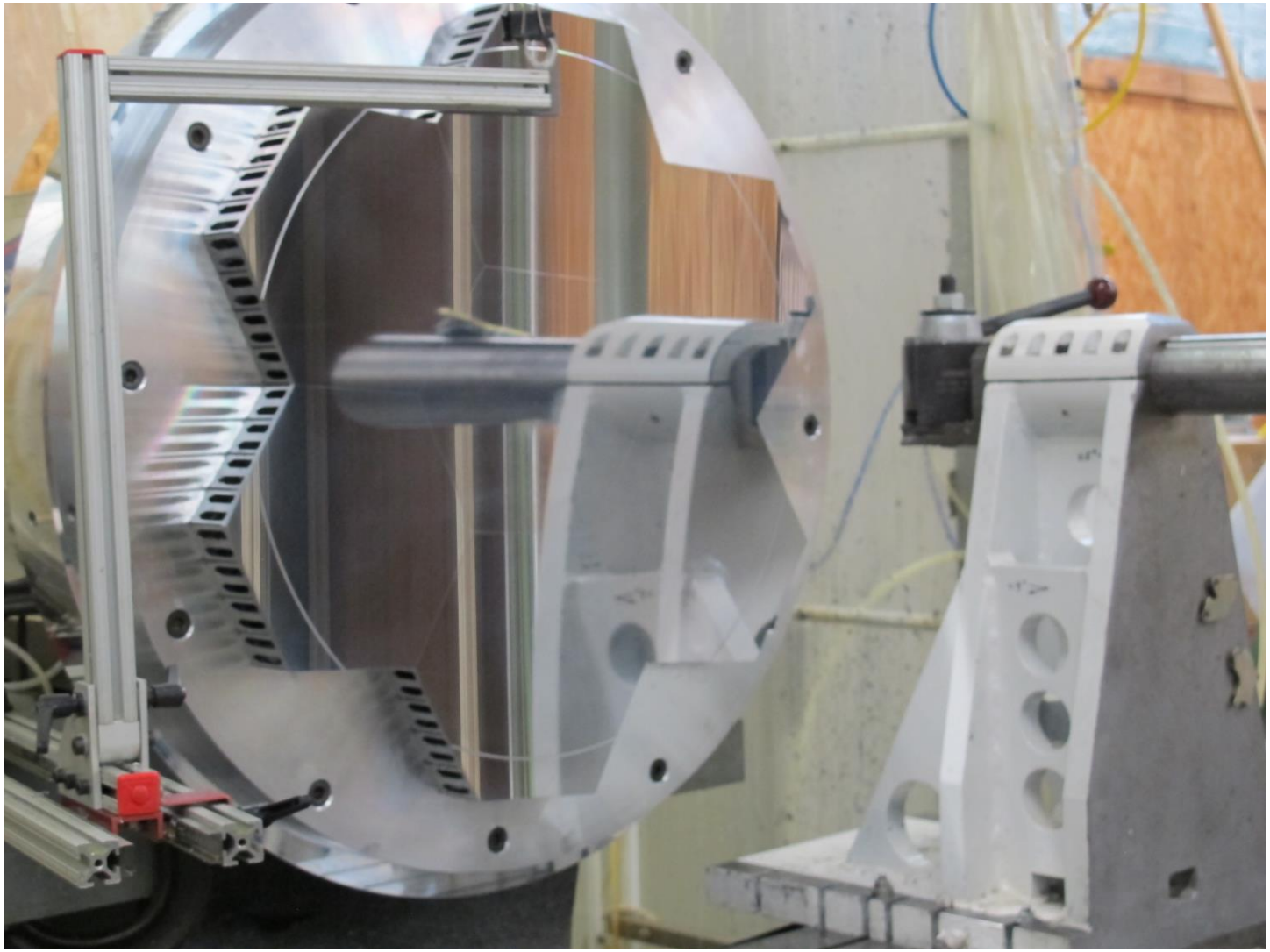
Properties of Al10SiMg Aluminum (10% Si) are similar to Alloy 6061-T651 with exception of higher Si



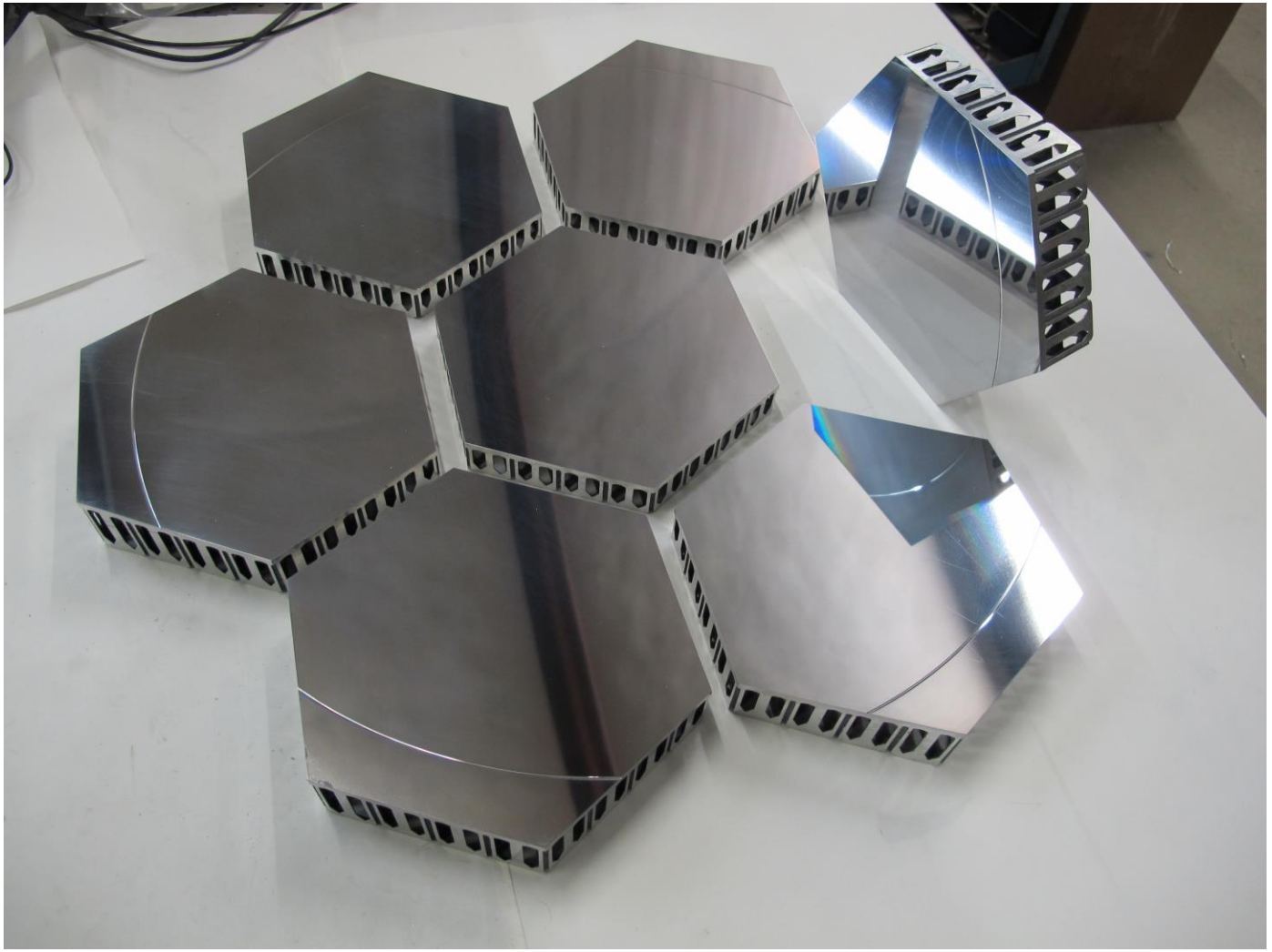
Generate 2.3 meter (90”) radius on 0.63 meter assembly



Single crystal diamond tool produces contour for optical testing

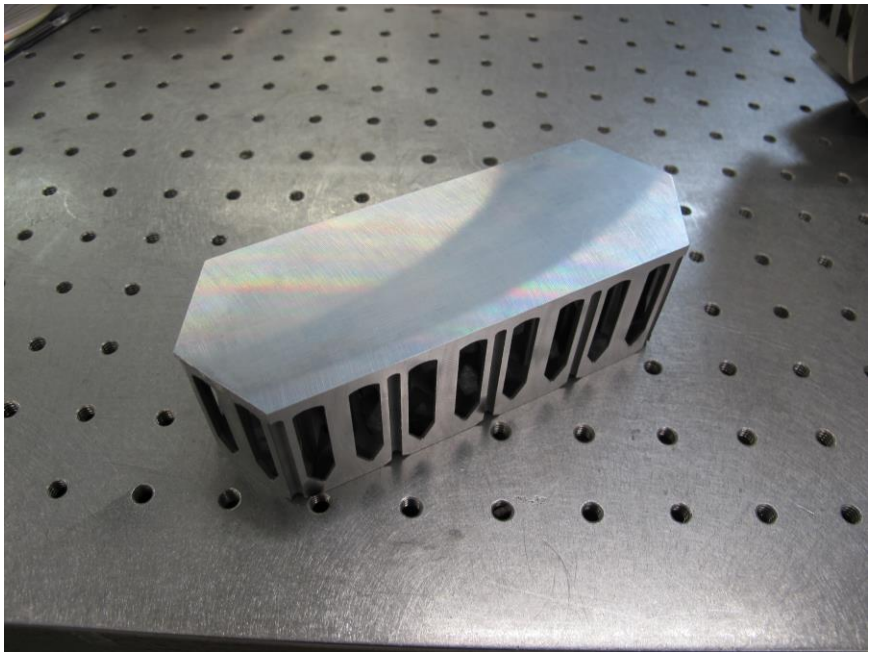


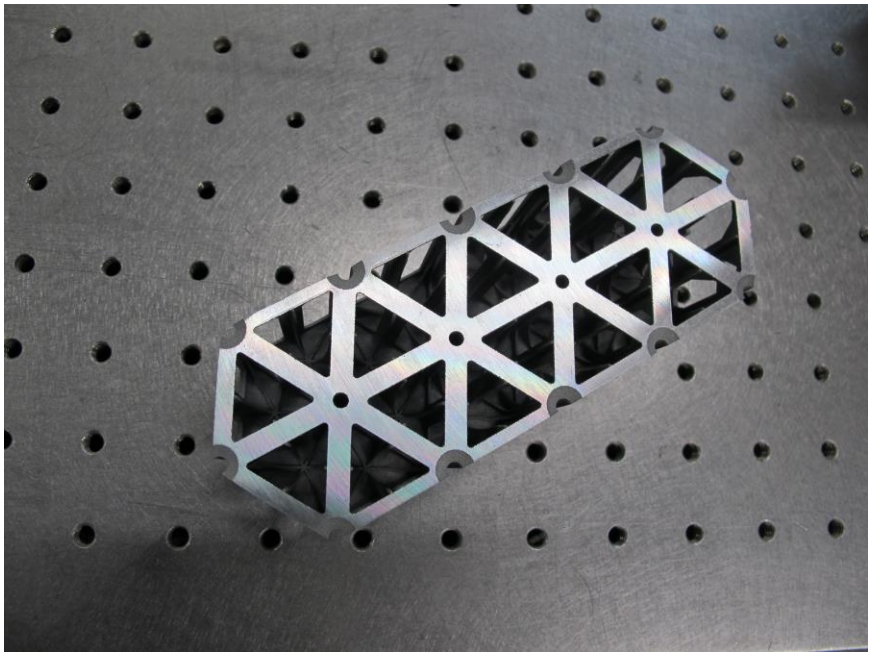
Spherical hexagonal mirror substrates ready for welding



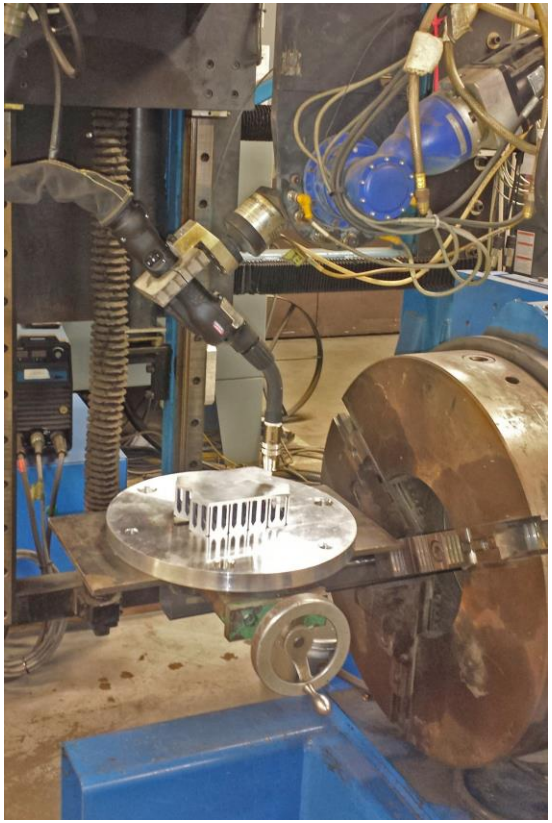
Additively Manufactured Weld Test Pieces.

Machined Additively Manufactured Weld Test Piece To Remove Surface Oxide For Welding





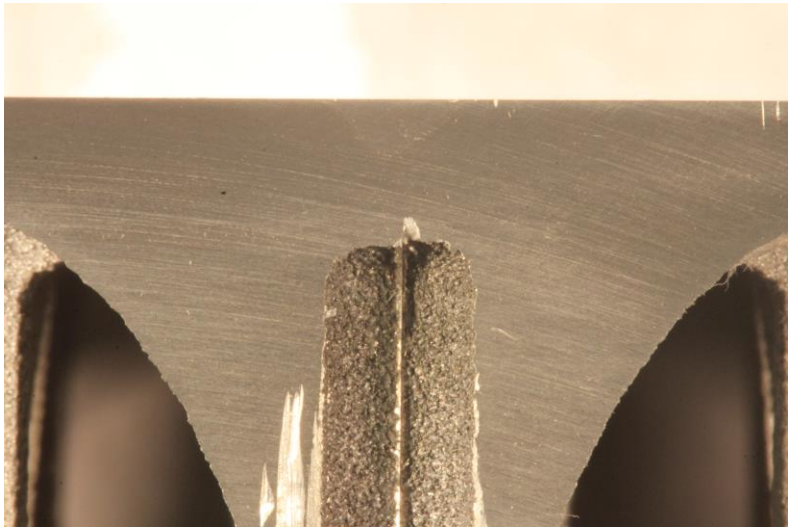
ARC Specialties Six Axis Laboratory Robotic Welder

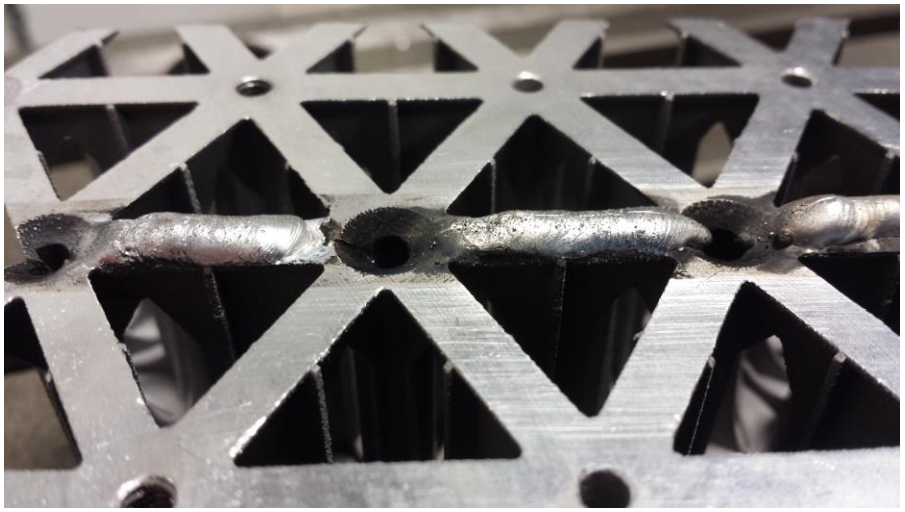


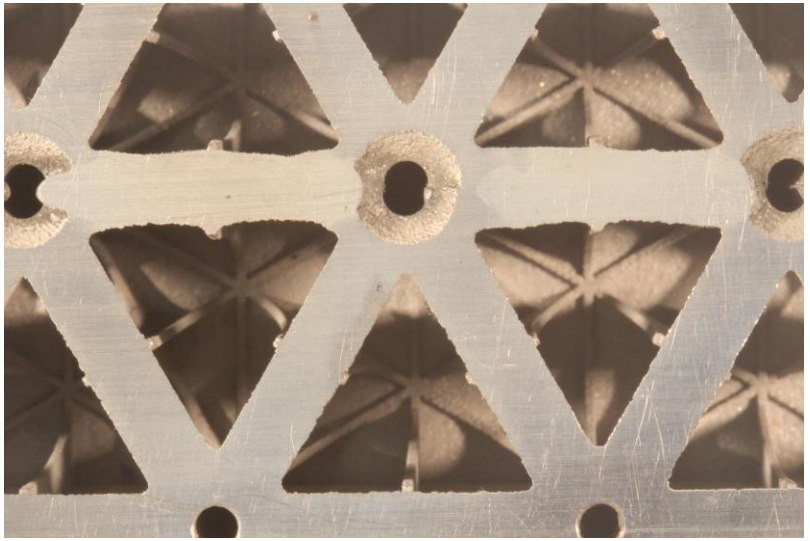
Welding Test Fixtures

Dallas Optical
Weld Test #4
10/25/2018
ARC Specialties
Houston, TX

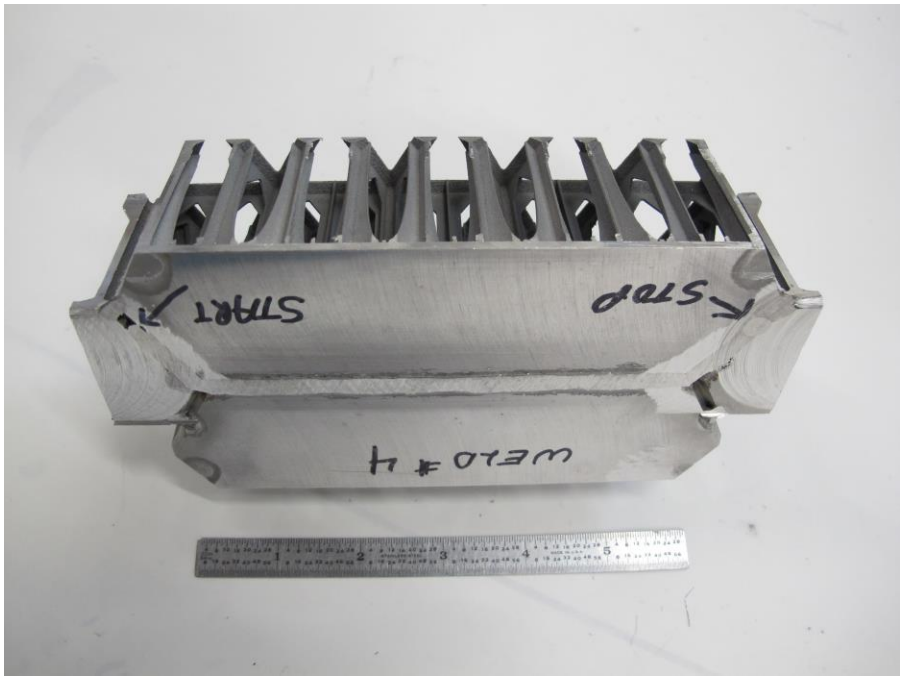
Welding Testing with GTA of Al10SiMg

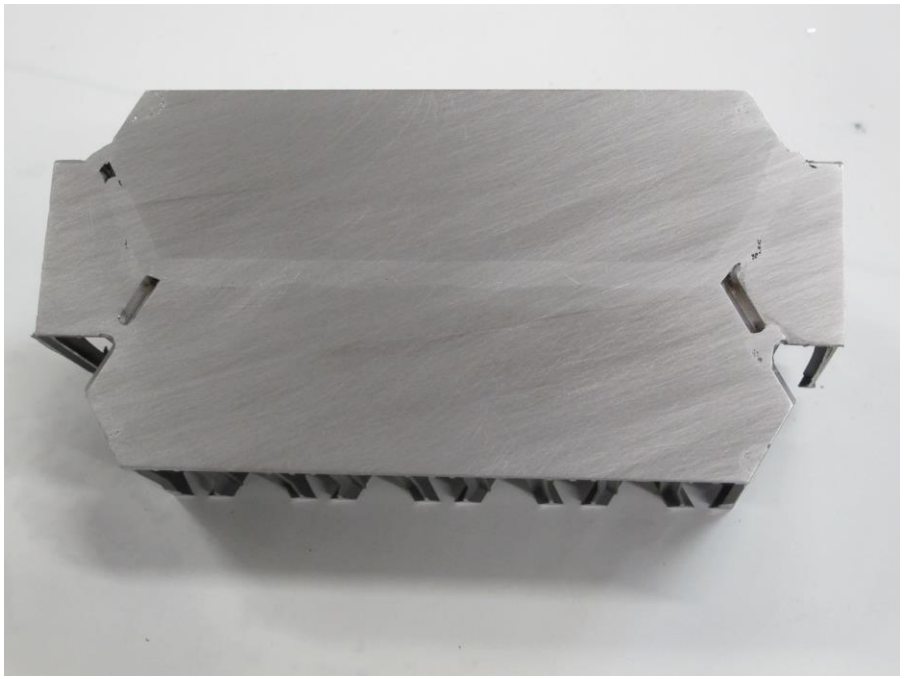




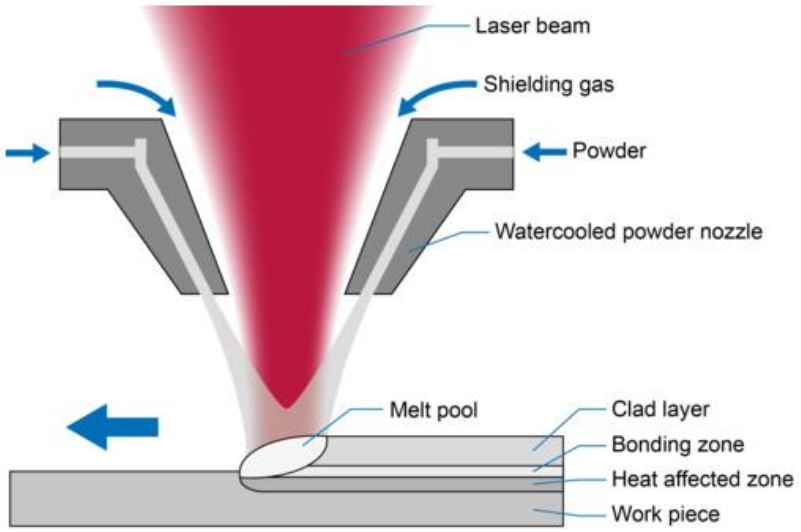


Gas Tungsten Arc (GTA) welding of Al10SiMg aluminum
Very fine grain low porosity welds

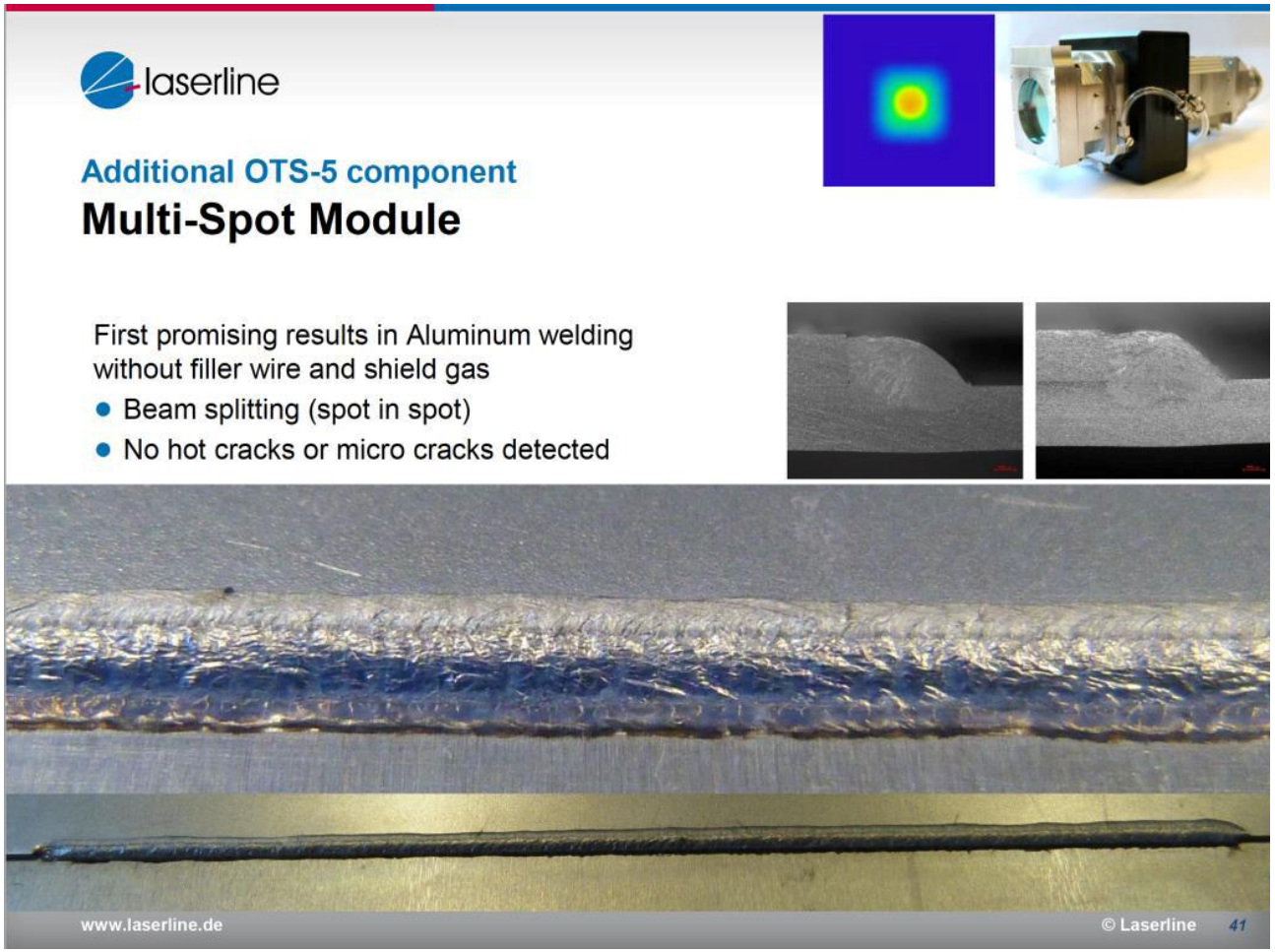




LWS Inc. ABB Welding Robot with Diode Laser



LWS Inc. Laserline LDF 5000-30 diode laser



SUMMARY

Additive manufacturing can quickly produce mirrors of arbitrary periphery and aspheric contour.

Diamond turning of aluminum substrates is a very low cost, very flexible manufacturing process for mirrors and mirror system metering structures.

Low (6-20 kg/sq. meter) areal density, very stiff metal mirror.

Joining additively manufactured aluminum segments offers the potential of making very large mirrors.