**Fabrication of Extreme Environment Materials for Large Parts Using Additive Manufacturing Methods**

**AM Process Development for High Temperature Superalloy IN939**

**Design of Large-Area Selective Laser Melting (LASLM)**

**Develop In-situ Microstructure and Mechanical Property Enhancement Process for SLM**

**The Challenge/Opportunity**

- AM process using high temperature superalloys for engine components is needed
- Few AM options exist for large metallic components
- Improved quality, microstructure, and mechanical properties of AM parts is needed

**Project Objective and Benefits**

- Develop AM process for IN939
- Design cost-efficient large area selective laser melting system (LASLM)
- Develop In-situ microstructure and mechanical property control for AM process

**AM Process Optimization of High Temperature Materials (IN939)**

A commercial 3D Systems ProX300 machine was used to develop machine parameters to yield dense parts with the IN939 powder.

**Microstructure and Hardness of AM IN939 samples**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Average</th>
<th>STD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>360</td>
<td>15</td>
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<tr>
<td>2</td>
<td>365</td>
<td>8</td>
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<tr>
<td>3</td>
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<td>4</td>
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<td>13</td>
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<tr>
<td>5</td>
<td>367</td>
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</tr>
</tbody>
</table>

**Summary**

- Process optimization completed for AM of IN939
- Demonstrated AM fabrication of 180 mm diameter IN939 engine component with a commercial SLM system.
- Completed the design of a cost-efficient LASLM and the demonstration of a small-scale system.
- Evaluated the feasibility of in-situ microstructure and mechanical property optimization using selective area forging (SAF).

**Milestone Status**

- Completed IN939 process optimization using commercial SLM system (Jan. 2018)
- Completed machine design of LASLM and demonstration of a small-scale system. (Feb. 2018)