LENS® Composites and Ceramics

A wide variety of composites and ceramic materials can be processed using LENS technology.

The term “composite materials” can encompass a wide variety of chemistries and combinations of materials. In laser deposition, composites usually consist of a ductile metal matrix coupled with a hard ceramic phase to give the desired properties, such as high wear resistance. Metallic matrices include nickel base, iron base, and titanium base alloys. The ceramic phase is often a carbide. Materials are chosen for wear resistance, lubricity, heat tolerance or other properties.

The LENS process is also capable of processing many pure ceramics, including zirconia, alumina, and silica. This is despite the fact that ceramics are typically difficult to melt-process, due to their high melting points, low thermal shock resistance, and often low absorptivity of the laser radiation.

Applications for these materials include wear resistant coatings for industrial components, wear resistant coatings for medical devices, rapid material development, and rapid manufacturing.

KEY FEATURES

- Highest Quality of Any Deposition Process
- Low Heat Input for Low Distortion
- High Wear Resistance Coatings
- Near-Net Shape Deposition
- Many Material Combinations

INDUSTRIES SERVED

- Oil and Gas
- Power Generation
- Aerospace
- General Industrial Machinery

Microstructure of titanium-boron composite. Photo Courtesy of UNT

Parts made directly from pure alumina ceramic. Photo Courtesy of WSU

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MATERIALS
Powder Specifications & Sourcing

Since LENS does not add, remove or alter the quantities of any chemical elements, the chemistry of the powder should match the chemical specification of the application. The buyer can specify the desired chemistry (for example, alumina, tungsten carbide etc) to the powder manufacturer.

Users can choose any vendor to supply powder. Carpenter, ATI, TLS, Praxair and Stellite are known worldwide suppliers of powder suitable for the LENS process. The typical powder size is 150 – 45 microns (-100/+325 mesh), although other sizes are acceptable. Optomec system owners can request the “LENS Powder Requirements” document for full details.

Microstructure
When composites are processed using the LENS system, the high melting point ceramic particles usually dissolve very slightly into the metallic matrix. Larger ceramic particles remain largely unmelted, and are embedded in the metallic matrix. Pure ceramics tend to exhibit directionally solidified microstructure with grains growing vertically.

Materials
With two powder feeders, the operator has the option to load the metallic powder in one feeder, and the ceramic into the other, and mix the powders on the fly to create a composite material. In this way, the chemistry of the composite can be graded from layer to layer, optimizing the properties of the coating.

<table>
<thead>
<tr>
<th>Composite Matrices</th>
<th>Composite Ceramics</th>
<th>Pure Ceramics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>TiC</td>
<td>Alumina</td>
</tr>
<tr>
<td>Nickel</td>
<td>WC</td>
<td>Zirconia</td>
</tr>
<tr>
<td>Cobalt</td>
<td>Hydroxyapatite</td>
<td>Silica</td>
</tr>
<tr>
<td>Titanium</td>
<td>Carbon Nanotubes</td>
<td></td>
</tr>
</tbody>
</table>

Microstructure of LENS-deposited alumina.  
Macrostructure of LENS-deposited alumina.  
Photo Courtesy of WSU