



## SURFACE ENGINEERING

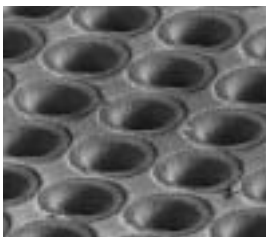
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### Laser Surface Modification of Orthopedic Implants

Several micro and macro processes have been developed utilizing a laser to modify the surface of a material. There are many reasons for surface modification ranging from stress reduction to improved surface area. Laser technology has been investigated for surface modification because of the non-contact and low heat input exhibited by the process.

Mound Laser & Photonics Center has implemented the use of a Nd:YVO4 diode-pumped laser system capable of producing 1064nm and 355nm wavelengths. This system has been fully integrated into a 4-axis workstation for maximum flexibility. Since the laser system produces two different wavelengths, it is capable of producing a wide range of features (~10 µm - 1000 µm) in materials ranging from metals, to polymers, to ceramics. In addition, the short pulse width of the system (~35ns) allows for good ablation efficiency of the material without putting extra heat into the part.

Some examples of laser surface texturing are shown below:



**Laser Texturing of Graphite**  
(75 µm diameter x 200 µm deep wells)



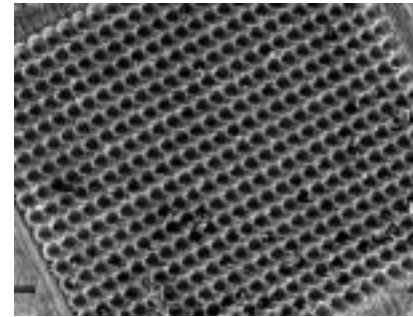
**Laser Texturing of Graphite**  
(75 µm diameter x 200 µm tall columns)

Within the orthopedic industry, current surface modification techniques are used to improve implant adhesion. These existing technologies are very labor intensive, and they often require that material be added to the implant and that subsequent heat treatment be employed. This heat treatment can change the physical size of the implant, a factor that needs to be accounted for.

The laser surface texturing process requires no subsequent processing, and no additional material needs to be added to

the implant surface. The process selectively ablates material from the surface and does not alter the chemistry or size of the implant.

This image shows laser surface texturing of titanium. The process was adjusted to produce circular wells in the material. The processing rate for this surface structure geometry and feature depth is 120mm<sup>2</sup>/min.



**Laser Texturing of Titanium**  
(100 µm Diameter x 100 µm Deep Wells)

Laser surface texturing also provides flexibility in the type of structure that can be placed on the implant. For instance, if certain areas of the implant require larger or smaller structures, the changes can readily be implemented via by the system computer.

The flexibility of the process, coupled with the *hands-off* nature of the operation, allows for straightforward automation. The process can be completely computer-controlled, and investigation is underway to incorporate process feedback monitors that permit in-situ process monitoring.

*Editor: Mound Laser & Photonics Center (MLPC) has conducted investigation into numerous areas of material surface modification via laser texturing since 1999. MLPC also offers contract R&D and job shop services in laser welding, laser micromachining, and laser marking.*

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