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Investigating the effects of laser exposure on diamond-containing composites surfaces

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Introduction. Laser-solid matter interaction is a complex process that involves several phenomena at different scales. At the macroscopic scale, the laser beam interacts with the surface of the material, leading to surface modification or material removal. At the microscopic scale, the laser energy can induce a range of physical and chemical processes, such as melting, vaporization, ablation, and chemical reactions. These phenomena can result in changes in the material properties, such as surface morphology, chemical composition, and mechanical properties.

The specific interaction mechanisms between the laser beam and the material depend on several factors, such as the laser wavelength, pulse duration, power density, material properties, and environmental conditions. The understanding of these mechanisms is crucial for the optimization of laser-based processes for material processing. However, The interaction of laser with diamond-containing composites is different from its interaction with other solids due to the unique properties of diamond. Diamond is a highly thermally conductive and transparent material, which makes it challenging to process with a laser. Unlike other materials, it has a very low absorption coefficient at visible and near-infrared laser wavelengths[1], which means that most of the laser energy is reflected or transmitted through the material without being absorbed. Therefore, to achieve a significant laser-material interaction, one needs to use a laser wavelength that is absorbed by the diamond material, such as ultraviolet wavelengths. Moreover, diamond-containing composites consist of a mixture of diamond particles and a matrix material, such as metal or ceramic. The laser interaction with such composite materials depends on the material's composition, as well as the size and distribution of the diamond particles within the matrix [2]. When the laser energy is absorbed by the matrix material, it can transfer the energy to the diamond particles through thermal conduction, leading to their heating and melting. This process can result in the formation of a molten diamond-containing layer that can be reshaped and re-solidified into the desired shape.

Body. This work was dedicated to use fiber lasers with several repetition rates (nano, pico and femtosecond) to investigate the influence of laser processing parameters (power density, pulse repetition rate) and scanning system parameters (pulse overlapping, number of passes) on the physical properties of the surface:

• Geometry (dimensions, anterior angle) and surface roughness of samples.
• Microhardness of the surface of the samples.

Conclusion. An optimal regime has been obtained for using lasers to shape the surface geometryof diamond containing composites.

Sources used:

[1] Y. Meng *et al.*, “Enhanced optical properties of chemical vapor deposited single crystal diamond by low-pressure/high-temperature annealing,” *Proceedings of the National Academy of Sciences*, vol. 105, no. 46, pp. 17620–17625, Nov. 2008, doi: 10.1073/pnas.0808230105.

[2] A. B. Spierings, C. Leinenbach, C. Kenel, and K. Wegener, “Processing of metal-diamond-composites using selective laser melting,” *Rapid Prototyp J*, vol. 21, no. 2, 2015, doi: 10.1108/RPJ-11-2014-0156.

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