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Micro-Laser-Assisted Machining: The Future of Manufacturing Ceramics and Semiconductors

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Ceramics and semiconductors are hard, strong, inert and lightweight. They also have good optical properties, wide energy bandgap and high maximum current density. This combination of properties makes them ideal candidates for tribological, semiconductor, micro-electromechanical systems (MEMS) and optoelectronic applications. Manufacturing these materials without causing surface and subsurface damage is extremely challenging owing to their high hardness, brittle characteristics and poor machinability. However, ductile regime machining of these materials is possible owing to the high-pressure phase transformation occurring in the materials caused by the high compressive stresses induced by the single-point diamond tool tip. In this study, to further augment the ductile response of the machined material, single-point scratch tests and diamond turning are coupled with the μ-LAM technique. The high-pressure phase is preferentially heated and thermally softened by using concentrated energy sources (i.e., laser beams) to enhance the ductile response of the material. The focus here is to develop an efficient manufacturing technique to improve the surface quality of ceramics and semiconductors to be used as optical devices (mirrors and windows). Machining parameters such as the depth of cut, feed, cutting speed and laser power are optimized to make the manufacturing process shorter and cost-effective.

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