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An Experimental Study of Micro-Machining of Hydroxyapatite Using an Ultrashort Picosecond Laser

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Abstract. Bio-ceramics typified by hydroxyapatite (HAP) are drawing more and more attention due to their unique properties including bioactivity, biocompatibility and proper mechanical hardness and strength. However, the machinability of HAP by using conventional methods is poor. An exploration of micro-grooving of HAP employing ultrashort pulsed laser is carried out in this study, and orthogonal experimental method is used with various factors considered including laser scanning times, high voltage level, pulse frequency, scanning velocity and focal plane position. Range analysis is conducted and the significance of selected factor on the groove profile is discussed. It has been found that microgrooves of width and depth varying between 20~45 μm without obvious thermal damage can be achieved when the parameters are properly selected, demonstrating the feasibility of the ultrashort picosecond laser in micro-processing of HAP. Meanwhile, cracks, recast layer and edge fracture occur in few cases, suggesting that the material removal mechanism in this process is not purely phase explosion as for femtosecond laser. The energy dispersive spectroscopy (EDS) comparison results between ablated and non-ablated surfaces illustrate an obvious change in the composition ratio of element oxygen (O), indicating that there may exist chemical reaction at the laser irradiation zone. Based on the analyses on groove profile and thermal damage, recommendations are made on processing parameters selection for micro-grooving of HAP.

Keywords: Picosecond laser; Bio-ceramic; Hydroxyapatite; Micro-grooving; Thermal damage.

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