

Tailored beam ultrafast laser drilling of crack-free blind holes in Al₂O₃ with vertical walls and flat bottom without recast and heat affect zones

Zhaoqing Li¹, Lin Li¹, Wei Guo¹, Olivier Allegre¹, Junlong Wang², Benhai Li², Xuefeng Wang²

¹*Laser Processing Research Centre, School of Mechanical, Aerospace and Civil Engineering, The University of Manchester, Oxford Road, Manchester, M13 9PL, UK*

²*Beijing Institute of Aerospace Control Devices, 52 Yongding Road, Beijing, 100039, Peoples Republic of China*

Corresponding author: zhaoqing.li@manchester.ac.uk

In this work, blind holes have been generated by using helical drilling method in alumina ceramic (Al₂O₃) using a femtosecond laser with 800 nm wavelength and a 1 kHz repetition rate. Effects on laser beam polarization state such as linear, circular, radial, and azimuthal on hole drilling quality were investigated. A strategy for producing blind holes of vertical walls and flat bottom was developed based on the tailoring of laser beam intensity distribution, wavefront, and polarization states. The results showed that blind holes of around 500 μm in diameter and a depth over 900 μm were successfully drilled with a flat bottom, high circularity, vertical walls without heat affected zones, cracks or debris. The inner wall surface roughness of the drilled holes was around 1 μm Ra.