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Laser drilling of alumina ceramics using solid state Nd:YAG laser and QCW fiber laser: Effect of process parameters on the hole geometry

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ABSTRACT

Nowadays a lot of lasers working at different parameters could be used for machining of a wide spectrum of materials. One of these materials is alumina ceramic as it is hard to machine using conventional methods due to high hardness and brittleness. In this paper the percussion drilling of alumina ceramics was performed by Nd:YAG laser and quasi-continuous-wave fiber laser. Effects of laser wavelength, pulse energy, pulse length and number of pulses were examined and the comparison of produced holes geometry was reported. The results show that it is possible to control the holes dimensions by changing lasers and parameters. Fiber laser provides generation of narrower holes due to its small spot and better beam quality together with high power densities. Shorter pulses 0.5 ms, high peak power 1 kW and energy density around 10 kJ/cm^2 are satisfactory for drilling, as they assured good holes circularity and less amount of melt. For Nd:YAG laser it was found that both entrance and exit holes diameters go up proportionally with the pulse length and pulse energy. The optimum parameters for this laser were pulse length 1 ms as good circularity and less amount of dross was obtained, and energy densities around 1 kJ/cm^2 leading to formation of hole with better quality. Moreover, higher number of pulses improves holes circularity.

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Izvirni znanstveni članek

Lasersko vrtanje aluminijeve keramike z uporabo trdninskega laserja Nd:YAG in vlakenskega laserja QCW: učinek procesnih parametrov na geometrijo luknje

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POVZETEK

Danes je številne laserske naprave, ki delujejo pri različnih parametrih, mogoče uporabiti za obdelavo širokega spektra materialov. Eden od teh materialov je aluminijeva keramika (aluminijev oksid), ker ga je zaradi visoke trdote in krhkosti težko strojno obdelovati z običajnimi metodami. V prispevku je opisano udarno vrtanje aluminijeve keramike s trdninskim laserjem Nd: YAG in vlakenskim laserjem. Proučili smo učinek valovne dolžine laserja, energije impulza, dolžine impulza in števila impulzov na geometrijo izdelanih lukenj. Rezultati so pokazali, da je z izbiro laserja in spreminjanjem parametrov mogoče vplivati na dimenzijo luknje. Vlakenski laser omogoča izdelavo ozkih lukenj, kar je posledica majhnega premera in boljše kakovosti žarka z visoko gostoto moči. Krajši impulzi 0,5 ms, visoka moč 1 kW in gostota energije okoli 10 kJ/cm2 so primerni za vrtanje, saj zagotovijo dobro cilindričnost lukenj in majhno količino taline. Za laser Nd:YAG smo ugotovili, da se premera vhodnih in izstopnih lukenj povečujeta sorazmerno z dolžino in energijo impulza. Optimalni parametri za ta laser so: dolžina impulza 1 ms, pri kateri je ugotovljena dobra cilindričnost, luknje pa vsebujejo manj srha; ter gostota energije okoli 1 kJ/cm2, ki zagotavlja luknje z višjo kakovostjo. Večje število impulzov izboljša cilindričnost lukenj.

PODATKI O ČLANKU

Ključne besede:
Aluminijeva keramika
Lasersko vrtanje
Trdninski laser Nd: YAG
Vlakenski laser QCW
Geometrija luknje

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