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Short Communication

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Effects of Pulse Duration and Heat on Laser-Induced Periodic Surface Structures

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Abstract:

Compared with traditional nanotexturing methods, an ultrashort-pulsed laser is an efficient technology of fabricating nanostructures called laser-induced periodic surface structures (LIPSS) on material surfaces. LIPSS are easily fabricated when the pulse duration is shorter than collisional relaxation time (CRT). Accordingly, ultrashort-pulsed lasers have been mainly used to study LIPSS, but they unstably irradiate while requiring high costs. Although long-pulsed lasers have low cost and high stability, the phenomena (such as the effect of pulse duration, laser wavelength, and heat) of the LIPSS fabricated using short-pulsed lasers with the pulse duration close to the maximum CRT, which is greater than femtosecond, have not been clarified. However, the nanosecond pulse laser has been reported to produce LIPSS, but those were unclear and ununiform. In this study, the short-pulsed laser with the pulse duration of 20 ps, which is close to the maximum CRT, was employed to clarify the effects of pulse duration and heat on the fabrication of LIPSS and to solve problems associated with ultrashort-pulsed lasers. First, a finite-difference time-domain simulation was developed at 20-ps pulse duration to investigate the effects of irradiation conditions on the electric-field-intensity distribution. Subsequently, experiments were conducted using the 20-ps pulse laser by varying conditions. The aspect ratio of the LIPSS obtained was greater than that of the LIPSS fabricated using ultrashort-pulsed lasers, but LIPSS were not fabricated at 355- and 266-nm laser wavelength. In addition, the short-pulsed laser experienced thermal influences and a cooling material was effective for the fabrication of LIPSS with high-aspect-ratio. This demonstrates the effects of pulse duration close to the CRT and heat on the fabrication of LIPSS.

Biography

Shuhei Kodama has completed his PhD at the age of 27 years from Tohoku University. He is an Assistant Professor of Tokyo University of Agriculture and Technology. His research activities focus on short-pulsed laser-induced periodic surface structures (SPLIPSS) to clarify principles and phenomena, to control LIPSS and to provide a material surface with various functionalities such as reduction of friction, water repellency, anti-reflection and bioaffinity. He gave 9 presentations and 3 lectures about SPLIPSS at international and domestic conferences, and published 8 papers in reputed journals. He is passionate about precision processing.

Publication of speakers

1. Study on the Creation of Fine Periodic Structure on V-Shaped Groove with Short-Pulsed Laser
2. July 2020 International Journal of Automation Technology 14(4):601-613
3. Effects of Pulse Duration and Heat on Laser-Induced Periodic Surface Structures
4. July 2020 International Journal of Automation Technology 14(4):552-559
5. Control of short-pulsed laser induced periodic surface structures with machining -picosecond laser nanotexturing with magnetic abrasive finishing- September 2019Precision Engineering 60

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