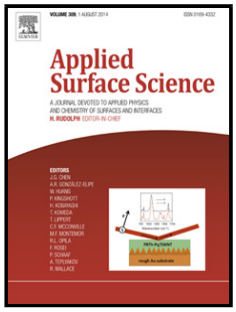

Title: Morphological features of silicon substrate by using different frequency laser ablation in air andwater

Author: J.Y. Xu H. Hu Y.L. Lei

PII: S0169-4332(14)01772-3
DOI: http://dx.doi.org/doi:10.1016/j.apsusc.2014.08.038
Reference: APSUSC 28491

To appear in: *APSUSC*

Received date: 4-6-2014
Revised date: 9-7-2014
Accepted date: 7-8-2014

Please cite this article as: J.Y. Xu, H. Hu, Y.L. Lei, Morphological features of silicon substrate by using different frequency laser ablation in air andwater, *Applied Surface Science* (2014), http://dx.doi.org/10.1016/j.apsusc.2014.08.038

The author affiliation, abstract and figure captions are listed as follows:

Author Affiliation: J. Y. Xu, H. Hu*, Y. L. Lei. Shenzhen Engineering Lab of Industrial Robots and Systems , Harbin Institute of Technology Shenzhen Graduate School, Shenzhen, Guangdong, 518055 China

Abstract: The interaction of the nanosecond laser (FWHM=30ns, ?=355nm) and monocrystalline silicon is investigated in air and water. Conventional optical and scanning electron microscopes are used to characterize surface ablation of the monocrystalline silicon. A numerical model is used to ascertain the time of the bubble motion in water. Morphological features of the laser-induced crater are different under various environments and frequencies. More debris is found when using high frequency ablation, and a larger zone is affected by heat when using low frequency ablation in air. There is no debris found in water, and the morphology of craters is better in low frequency ablation than that in high frequency ablation because bubbles generated by high frequency ablation affect laser transmission.

Figure Caption:
Fig. 1 Schematic of wafer singulation configuration Fig. 2 SEM images of silicon after nanosecond laser ablation in air (a) 3Hz
(b) 2 kHz (c) 100 kHz (d) Low magnification images of 100 pulses Fig. 3 Schematic of the laser ablation mechanism in air [28] Fig. 4. SEM images of silicon after nanosecond laser ablation in water (a) 3Hz (b) 2kHz (c) 100kHz Fig. 5. Schematic of the influence of bubbles in laser spread Fig. 6. The relationship between velocities versus time