Investigation of ripple pattern formation by Bessel Gaussian femtosecond laser beam on Si and Al surface in submicron meter scale; polarization effect

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Introduction

The effects of the periodical ripples to the sub-micron meter laser machining with linear polarization is to deteriorate the machining performance [1], however, it works rather beneficial to form trenches of ~100nm width by scanning the laser beam in perpendicular to the laser polarization. In the present work we investigate the effect of the ripple formation associated with the sub-micron machining by the Bessel beam on the micromachining performance with the fluence lower than the ablation threshold and various polarization.

Experimental

The laser beam with the wavelength of 768nm and pulse duration of 160 fs operated at 489Hz was focused to the sample surface in the vacuum chamber. The optical system produced Bessel zone at ~40mm from the apex of axicon, forming a ~1μm spot on the sample surface. Polished c-Si with the surface orientation of (1,0,0) and thin Al film deposited on glass plate, were used as samples. The various polarization state, linear, circular, radially, and azimuthally, were used for the focused laser beam. The polarization depending features of the ablated patterns were observed with the Scanning Electron Microscope (SEM).

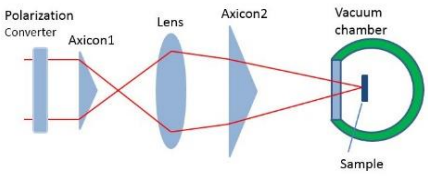

Fig.1 Experimental setup

Results

Fig.2 present the SEM image of the laser formed pattern on c-Si with various polarizations; (a) ripple pattern in perpendicular to the electric field with period of 630nm, (b) radially formed ripple pattern with the period of 610 nm by radial polarization, (c) co-central ring patterns with the period is 730nm by azimuthal polarization in air.

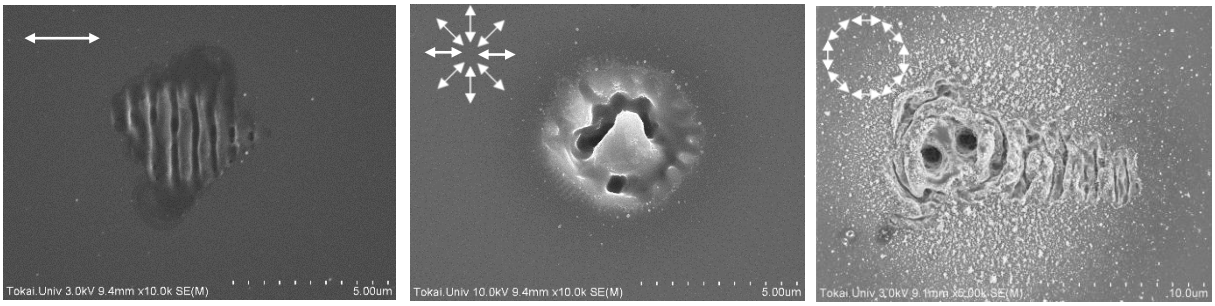

Fig.2(a) linear polarization, ripple period:630nm.
(b) radial polarization, ripple period:610nm
(c) azimuthal polarization, ripple period:730nm.

[1] to be published on Appl. Surf. Sci. (2015)