Self-Organized Formation of Patterns on Tin Irradiated with Femtosecond Laser

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We used a Ti:Sapphire femtosecond laser (775 nm wavelength, 150 fs pulse duration, 1000 kHz repetition rate, intensity of above $10^{12}$ W/cm²) to irradiate a polished surface of polycrystalline tin in an ambient environment and observed a well-developed surface modulation with a period of 1.4-2.8 micron. We further observed that the ripple orientation was influenced by the crystallographic orientation of the tin surface, in contrast to usual observation that the ripples are perpendicular to the beam polarization. The classical model on laser-induced rippling predicts the dependence of the ripple period on the laser wavelength. In contrast, our experiments demonstrate that the ripple period increases logarithmically with fluence for the fixed laser wavelength used. The evolution of ripples indicates that the surface periodic patterns are not formed due to “direct writing” in the ablation process and they are likely to be due to some spontaneous relaxation process on the highly non-equilibrium surface after the ions generated in the multiphoton ionization process left.