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Measurement of excitation and melting processes of the solid silicon surface excited by ultra-short laser pulses

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Transient reflectivity spectrum from the crystalline silicon irradiated with femtosecond laser pulses was observed as a function of the delay from pumping the surface. The sample was excited by focused optical pulses of wavelength and duration of 786nm and 120fs, respectively. The fluence at the center of the near-Gaussian beam profile was 0.65J/cm^2, which was well above the ablation threshold. Probe pulse used for this measurement was a white continuum with whole visible spectral range, generated from a short photonic crystal fiber of 1cm in length. The reflectivity spectrum, obtained in this experiment, well reproduces the published data for the crystalline silicon before the pump irradiation, however, it shows marked difference from that of crystalline, liquid, or amorphous states. The results show the peak reflectivity wavelength increases in ~1ps after the laser excitation. In another word, the time history of the reflectivity of the probe pulse depends on the probe wavelength. The results of the current experiment suggest that the strongly excited silicon is not in the liquid state within ~1ps after the excitation. The energy band of crystalline Si, which determines the optical reflectivity, is known to collapse as the inter- atomic distances increase. We consider the unusual behavior of the temporal reflectivity is due to the energy band shrinkage of the expanding crystal structure.