Online monitoring of laser induced periodic surface structures formation on polymer films by grazing incidence small angle x-ray scattering

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Resume: We report on the formation of laser induced periodic surface structures (LIPSS) upon irradiation with the fourth harmonic of a Nd:YAG laser (266 nm, pulse duration 7 ns) followed online by synchrotron Grazing Incidence Small Angle X-ray Scattering (GISAXS). Spin coated films 100-200 nm thick of different polymers were irradiated at repetition rates between 1 and 10 Hz employing laser fluences below the corresponding ablation threshold. In situ measurements were performed at the BM26B at the ESRF in order to study the evolution of the structural features online upon repetitive irradiation and to obtain information about the mechanisms involved in LIPSS formation. Laser irradiation was performed at normal incidence with the laser polarization parallel to the propagation of the X-ray beam. LIPSS parallel to the polarization direction and with final periods close to the laser wavelength were obtained, as confirmed by atomic force microscopy. The number of pulses needed for the onset of LIPSS formation and for achieving the optimal order of the structures varies for the different polymers. It has been verified that both absorption coefficient and the glass transition temperature of the polymer are crucial magnitudes for the onset of LIPSS formation. The real time monitoring allows online optimization of both laser fluence and repetition rate for LIPSS formation.