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INTERACTION OF INTENSE ULTRASHORT XUV PULSES WITH SILICON

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IV-th Generation Light Sources provide extremely intense, ultra short pulsed radiation in the XUV spectral range. One of them – FLASH (Free electron LaSer in Hamburg) - emits $10^{11\text{-}13}$ photons of the energy in the range of 30-100 eV, formed in 25 fs long bunches [1]. Its radiation can be focused down to the spot of 10 µm diameter to study the processes of the radiation damage to solids samples [2].

The irradiation of solid materials with such short wavelength femtosecond pulses offers a number of advantages. First of all, it permits a high degree of electronic excitation but with a strongly reduced influence of optical nonlinearities *i.e.*, multiphoton absorption and free carrier absorption. Moreover, for frequencies range between the plasma frequency and the frequency of the innershell absorption edge, the absorption length for solids varies over orders of magnitude. Therefore, ultrashort XUV pulses allow the preparation of rather well-defined excitation conditions for a variety of excitation depths.

We report on the results of experiments performed at FLASH on the interaction of ultrashort high intensity 10^{12}–10^{14} W/cm^2 XUV pulses with solid silicon surfaces. Silicon is a suitable material for comparisons, broadly studied with femtosecond optical lasers and picoseconds XUV lasers. Moreover it is a standard substrate material for for the optical coatings in XUV optics where radiation damage is a key issue. Samples were irradiated by single shots of FLASH radiation. The permanent structural modifications of the irradiated surfaces were characterized by means of phase contrast optical microscopy, AFM (see Fig. 1), Raman spectroscopy and X-ray micro diffraction.

Mechanisms of different, intensity dependent stages of the surface damage are described. Damage thresholds of each stage are estimated for various excitation depths. The influence of the energy diffusion/penetration on the damage thresholds is presented. The results are discussed regarding the problem of radiation damage of optical surfaces.

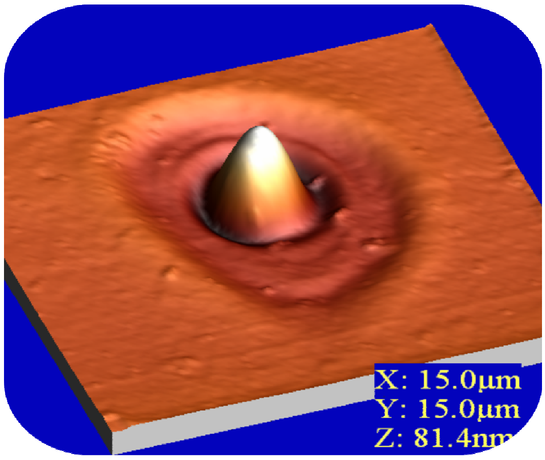

Figure 1. AFM depth map of the irradiation spot on the Si sample.

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