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STUDIES OF STRUCTRURAL CHANGES INDUCED BY UV AND VUV LASER PULSES

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Investigations of the interaction of laser radiation with optical materials have remained strenuous in the last decade. Especially, the interaction of ultra short laser pulse with matter has been studied. In the research the influence of the pulse duration [1, 2] and the material [3-5] on the ablation threshold were taking into account but many questions referred to ablation remain open as before. In order to reveal differences in results of interaction of short (ns) and ultra short (fs) laser pulses with matter, we carried previously out experimental studies by means of the interference–polarizing microscopy using the Nomarski reflection contrast, atomic force microscopy, and theoretical simulation of the process. The interaction with matter of ns laser pulses consists in thermal processes. The energy of laser radiation is transferred into the lattice in the form of a thermal energy in a nanosecond time scale causing melting of the surface layer. Next recrystallisation occurs which is continued after the laser pulse. We investigated these effects in single silicon crystals as well as in implanted samples. In dependence on laser annealing conditions (the energy density and duration) poly-crystallisation, structural reordering or creation of micro-crystallites on amorphous layer occurs [6,7]. Interaction of fs laser pulse with matter differs from that of ns pulse. XUV radiation permits a high degree of electronic excitation. The temperature of the electronic system grows up rapidly (in a femtosecond time scale, < 100 fs). Further, at a picosecond time scale the electron gas cools down by the heat transfer to the crystal lattice. If the lattice temperature reaches the phase transition point, the damage occurs. The depth of the damaged volume increases due to the thermal diffusion in the lattice that happens on a nanosecond time scale. We studied the irradiation damage in silicon single crystals [8,9].

The aim of the present work is an X-ray characterisation of materials in which structural modifications were induced with nanosecond pulses generated by excimer laser and the intense XUV femtosecond pulses generated by the TESLA test facility free electron laser (TTF FEL) at DESY, Hamburg. The results was obtained by X-ray diffraction method using synchrotron radiation at the W1.1 beam line at DESY-Hasylab. The monochromatic X-ray beam of the wavelength λ = 1.54056 Å was applied. The measurements were recorded with 2θ scans in the glancing incidence geometry and with ω-2θ scans. This method permitted us to determine the quality of crystal structure of samples. The samples were investigated before and after irradiation with laser radiation, this way the changes in crystallographic structure causing by the ablation were revealed, namely the creation of micro-crystallites on the amorphous or polycrystalline surfaces of studied samples was observed.

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