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Focusing of XUV laser beam with short focal length mirror

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Experiments with ablation of a different materials (PMMA, gold-covered PMMA [1], Mo, W, SiC [2], LiF, CsI [3] and others) by XUV laser pulses focused by spherical (R=2100 mm) Si/Sc multilayer mirror with a long focal length have been performed earlier.

In this work we present results of focusing of nanosecond XUV laser pulses at wavelength of 46.9 nm by multilayer-coated mirror with short focal length. As a source of XUV laser beam was used discharge plasma driver based on high current capillary discharge in argon. The laser beam of 1.5-ns FWHM duration was focused by spherical (R=60 mm) Si/Sc multilayer mirror on the surface of three samples: thick gold-covered PMMA (thickness of golden layer of about 200 nm), thin gold-covered PMMA (thickness of golden layer of about 6 nm) and pure PMMA. The mirror was positioned at normal incidence with the purpose of minimizing aberrations, and the reflected beam was focused onto the narrowest side of a thin sample strip (Fig. 1). Laser ablation of each footprint on the samples has been performed by single laser pulse with an energy of about 50 μJ (in a primary beam). Position of samples for ablation was changed in a range from - 0.5 mm to + 0.5 mm in axis of radiation (where 0 mm is the focal point of mirror). All ablated footprints were analyzed by optical microscope and by atomic force microscope. Unfortunately, analysis of the sample with a thick golden layer on PMMA was unsuccessful. On the other hand analysis of the other samples shows that the maximal depth of ablated craters (which is associated with the smallest craters) in the case of thin gold-covered PMMA was about 600 nm and in the case of pure PMMA was about 900 nm. The smallest craters, tens μm in diameter, were obtained at vicinity of focal point. Ablated footprints of both analyzed materials has an interesting structure (Fig. 2): deepest part with lightly visible spherical aberrations with a relatively large rayed zone. The central discontinuity in the ablation pattern is caused by the shadow of the sample holder that blocks a portion of the incoming beam.

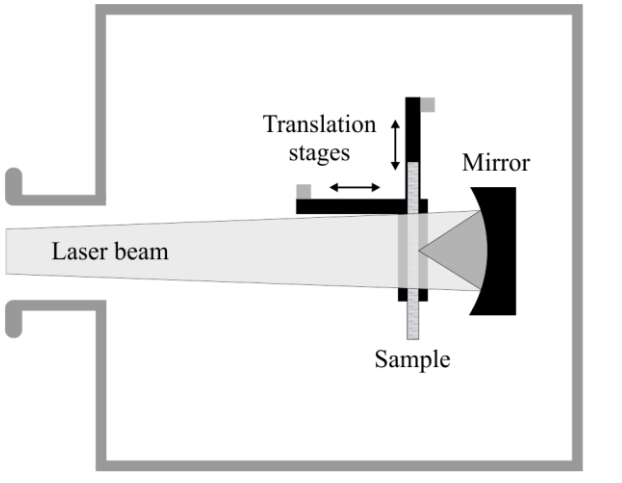

Figure 1 – Schematic of the XUV laser ablation setup

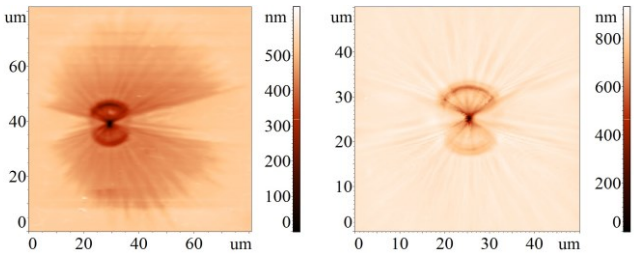

Figure 2 – Ablation footprints on gold-covered PMMA (left) and pure PMMA (right) in vicinity of focal point of mirror analyzed by AFM microscope

References

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