RA03

INVESTIGATION OF STRUCTURE MODIFICATIONS IN MATERIALS IRRADIATED BY ULTRA-SHORT PULSES OF 4th GENERATION XUV FEL SOURCE

J.B. Pełka[1*], M. Bittner[2], L. Juha[2], M. Jurek[1], D. Klinger[1], J. Krzywiński[1], R. Nietubyć[1], K. Sokolowski-Tinten[3], R. Sobierajski[4], and T. Tschentscher[5]

[1]*Institute of Physics, Polish Academy of Sciences al. Lotników 32/46, 02-668 Warsaw, Poland,*

[2]*Institute of Physics Academy of Science of Czech Republic, Na Slovance 2, CZ-182 21 Praha 8, Czech Republic*

[3]*Institut für Optik und Quantenelektronik, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1 07743 Jena, Germany*

[4]*Warsaw University of Technology, Department of Physics, Pl. Politechniki 1, 00-661 Warsaw, Poland*

[5]*Hasylab at DESY, Notkestrasse 85, D-22603 Hamburg, Germany*

Keywords: 4th generation light sources, radiation damage, structure modification, morphology

**) e-mail: pelkay@ifpan.edu.pl*

The XUV TESLA Test Facility Free Electron Laser, a IVth generation radiation source being progressively constructed in Hasylab at DESY, Hamburg, is amongst the most powerful sources of EM radiation ever built [1,2]. The TTF FEL delivers a highly coherent radiation of peak power of the order of 1 GW in a short pulse of only 50-100 fsec. During the Phase I of the FEL facility activity, the emitted photon energies were 12-14 eV, In the Phase II, to be achieved in 2005, the photon energy will reach 30-40 eV. Energies in the soft and hard X-ray region are expected to be attained in the next few years. Combination of such power levels typical to laser ablation using conventional pulsed lasers working in optical wave-length with extremely short pulse duration, unreachable in the regions of XUV to X-rays with other known devices, makes it possible to testify theoretical predictions indicating different mechanisms of energy absorption and dissipation, than that occurred when the irradiation pulse durations are in the picosecond or nanosecond region [3-5]. Experimental results collected during the Phase I of the FEL activity of material damage and surface modification due to beam interaction supported in part these predictions [6-7].

The aim of this presentation is to show chosen examples of characteristic structural changes observed in solids irradiated during the Phase I of the TTF FEL activity and to discuss some methods suitable to structure characterization, specific to the strong 4th generation sources. Future experiments at the TTF FEL as well as a discussion of expected benefits to the science and technology, emerging from the new generation sources will be also presented.

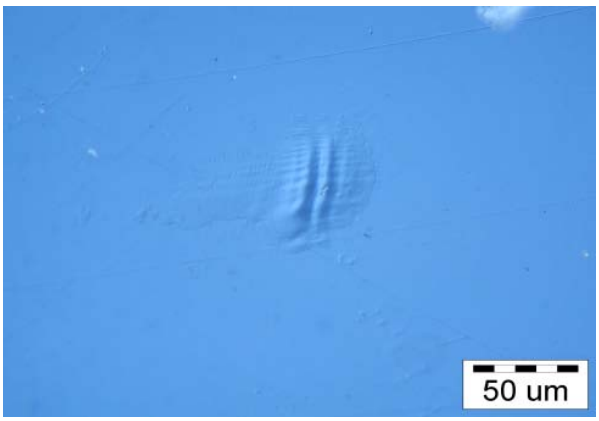

Figure 1. Relief of the FEL beam intensity projected by a single shot of fluence 0.4 J/cm^2 in a PMMA target.

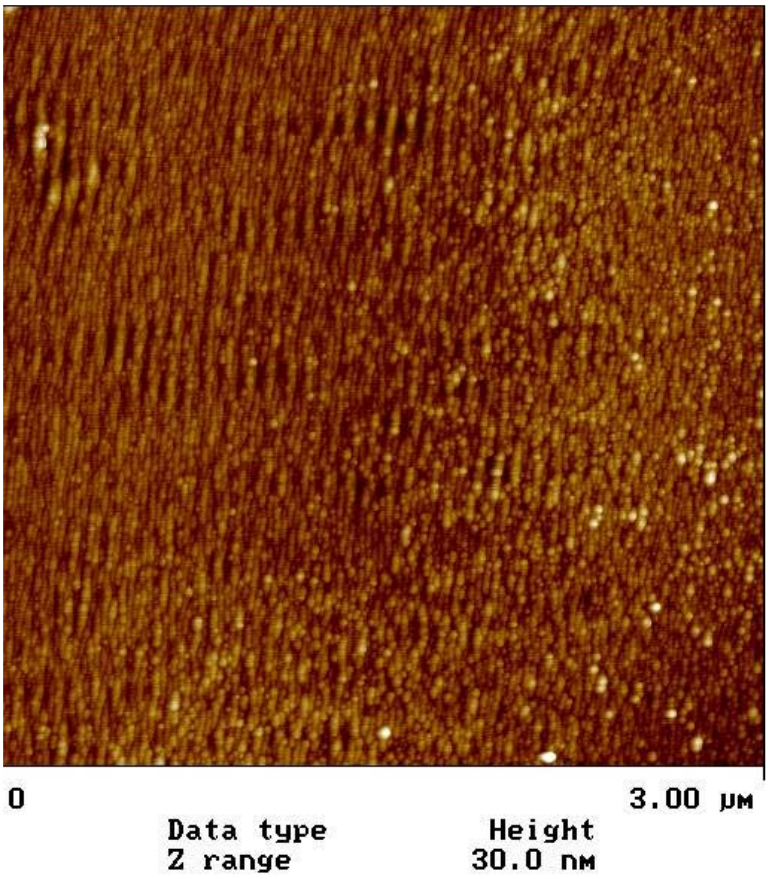

Figure 2. Periodic surface structure induced by the FEL beam in carbon film.

Acknowledgments: This work was partially supported by the State Committee for Scientific Research (Poland), grants no. 72/E-67/SPB/DESY/P-03/2004-2006, 72/E-67/SPB/5.PR UE/DZ27/2003-2005 and by G1MA-CI-2002-4017 (CEPHEUS) of the European Commision.

References

[1] A. Cho, *Science* **296** (2002) 1008-1010.

[2] V. Ayvazyan *et al*., *Eur. Phys. J. D* **20** (2002) 149-156.

[3] D. von der Linde, K. Sokolowski-Tinten, *Appl. Surf. Sci.* **154-155** (2000) 1-10.

[4] H.O. Jeschke, M.E. Garcia, and K.H. Bennemann, *Phys. Rev. Lett.* **87** (2001) 015003-(1-4).

[5] S.-S. Wellershoff, J. Hohlfeld, J. Güdde, E. Matthias, *Appl. Phys. A* (*Suppl.)* **69** (1999) S99-S107.

[6] J.B. Pełka, A. Andrejczuk, H. Reniewicz, N. Schell, Z.R. Zytkiewicz, D. Klinger, L. Juha, *J. Alloys Compds.* **382** (2004) 264-270.

[7] L. Juha, M. Bittner, D. Chvostova, J. Krasa, Z. Otcenasek, A.R. Prag, J. Ullschmied, Z. Pientka, J. Krzywinski, J.B. Pelka, A. Wawro, M.E. Grisham, G. Vaschenko, C.S. Menoni, J.J. Rocca, *Appl. Phys. Lett*. **86** (2005) 034109.