The scientific report of Renato Redaelli for the

EXCHANGE GRANT: Interaction of Short-/Ultrashort- Laser Radiation (femto- second time domain) with Metal (Ti; Al; Inconel 600) Targets

(ESF activity entitled, "Super-Intense Laser-Matter Interactions"-SILMI)

From 09/08/2010 to 10/09/2010 in the , Csc. Czech Technical University in Prague Czech Republik, Faculty of Nuclear Sciences and Physical Engineering,

host Prof. Prof. Ing. Jiri Limpouch

Reference code: 2998

The research objective of this visit was experimental and theoretical study of interaction of ultrashort-laser radiation with solid targets using the femto second laser facility at the University of Prague, Czech Republik.

The experimental work, at Prague University, was concentrated on the surface modification of solid targets using Ti:Sapphire laser. The laser was operated with the following conditions: pulse energy up to 7 mJ for λ_l= 800 nm. Pulse duration was 60 fs. High quality bulk materials, like aluminium, titanium, copper, etc., were irradiated. We emphasise that these materials, among other, are important for industry/nuclear complex. Also, some of these (like titanium) are of high importance for possible application in medical domain. The titanium as a material/implant shows excellent bio-compatibility with human body. In this context its surface state (e.g. morphology) is essential. One of promising method for surface morphology modification is laser based method. Laser intensity on the all used targets was about 10^{15} W/cm^2. Irradiation was performed in vacuum (~ $5 \cdot 10^{-3}$ mbar). Initial analysis of the modified target surface were analysed by optical microscope (OM). Detailed characterization of all targets will be continued at the Vinca Institute, Belgrade by X-ray analysis (XRD), scanning electron microscopy (SEM&EDAX), atomic force microscopy (AFM), Focused Ion Beam (FIB) device, etc. These analyses will give insight on morphological and structural changes as well as on various phenomena, e.g. ablation rate, damage threshold. We emphasize that the data available in the literature on the picosecond domain phenomena, on these types of targets, are further insufficient.

The results will be presented in International Journals and Conferences.

Comparison of the present results obtained in Prague, with our recently measured results at University Milano-Bicocca (ns/μs- and fs- lasers were used) will give important information for possible future applications.

Generally, surface modifications of target induced by laser radiation, among other, have shown dependence on beam characteristics: the laser pulse energy density (fluence), laser intensity, laser pulse duration, number of accumulated pulse, wavelength, etc. Initial investigations of the present experimental results performed at the University of Prague have shown the following phenomena: craters creation on Al, Ti and Cu (Figure 1); appearance of hydrodynamic effects in the form of resolidified droplets (especially expressed for Al) and, appearance of the plasma in front of the target. Presence of plasma implying of possible x-ray production. In this context the first efforts were done.

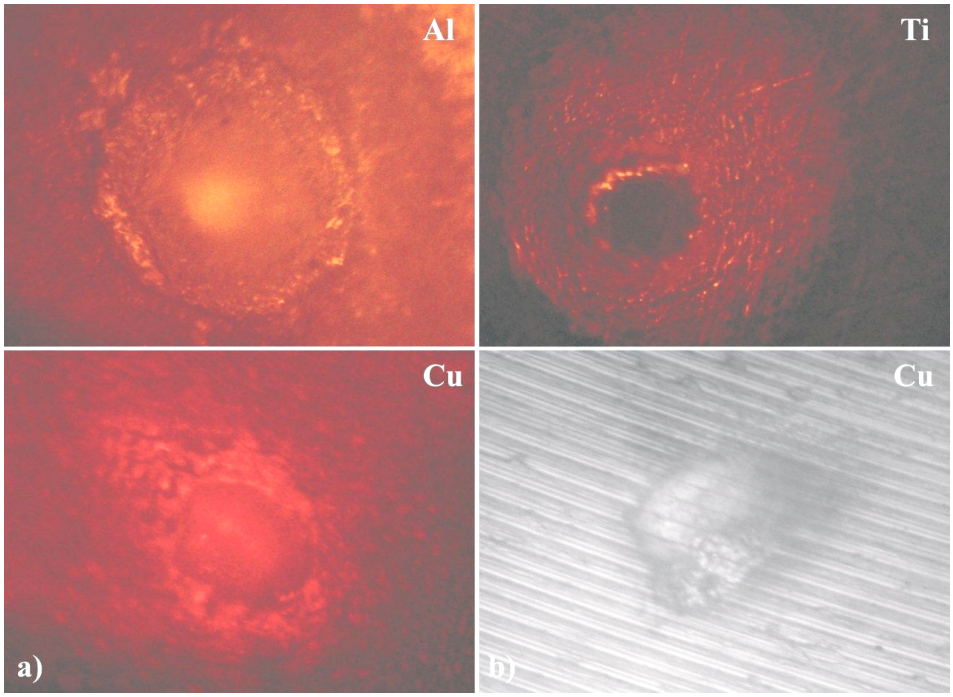

Figure 1. 800 nm fs Ti:Sapphire laser-induced surface modification of Al, Ti and Cu target. (The view of damages/craters for Al, Ti and Cu, after 100 pulses.

Also we performed preliminary studies of possible realization of experimental set up to measure intense magnetic fields in the Mega gauss range produced in the interaction of super intense laser fields with matter. In the course of this Exchange Grant the experiments were realized in collaboration with Prague host team, Prof. Jiri Limpouch, Dr. Michal Drahokoupil. For their assistance and hospitality I want to thanks. Present experimental data will result in significant scientific publications. I warmly acknowledge the support of the ESF activity, "Super-Intense Laser-Matter Interactions"-SILMI.

15 September 2010

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