Project no: PN-II-ID-PCE-2011-3-0522: « Giga and terra-watt laser interaction with carbon, tungsten and beryllium films »

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Scientific report (Abstract)

15 December 2012

During the year 2012 were performed the following activities:
Direct laser irradition

The laser irradiation of the carbon, tungsten and beryllium targets was performed using the following conditions:
A femptosecond high power laser on the 800 nm wavelength and 70 fs pulse duration was used for a direct irradiation. The laser energy per pulse was about 6.3 mJ. The focusing lens have had a focal distance of 300 mm. The irradiation scheme is presented in Fig.1, while in Fig.2 one can see the photograph of the experimental system

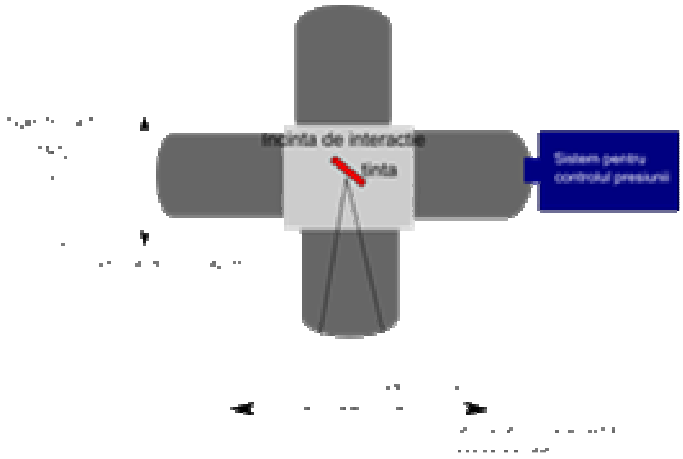

Fig.1 Irradiation scheme

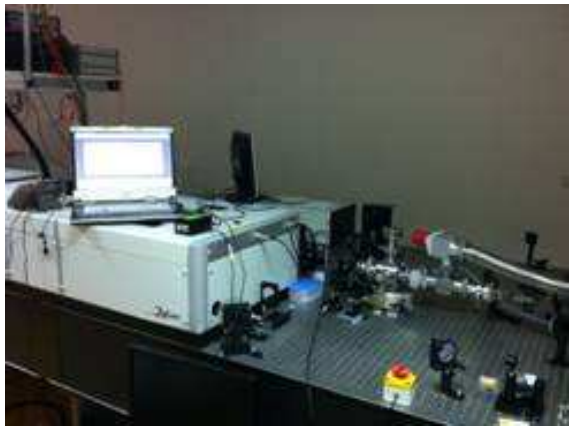

Fig.2 Photograph of the experimental system

Was changed the pulse energy, the total number of pulses and the ambiental gas (Air, Ar) , as shown in Table 1. (For C and Be irradiation were chosen similar conditions

Table 1. Irradiation conditions of the W target

W target, 45 dgree incidence			
Position	Energy (mJ)	Pulse no.	Pressure
1	6.3	1000	2.2*10^-1mbar air
2	6.3	200	
3	6.3	20	
4	6.3	1	
5	1.9	1000	
6	1.9	200	
7	1.9	20	
8	1.9	1	
9	0.6	1000	
10	0.6	200	
11	0.6	20	
12	0.6	1	
13	6.3	1000	100mbar air
14	6.3	200	
15	6.3	20	
16	6.3	1	
17	6.3	1000	1000mbar air
18	6.3	200	
19	6.3	20	
20	6.3	1	
21	6.3	1000	1 bar Ar
22	6.3	200	
23	6.3	20	
24	6.3	1	

Durring irradiation the following optical emission spectra were recorded:

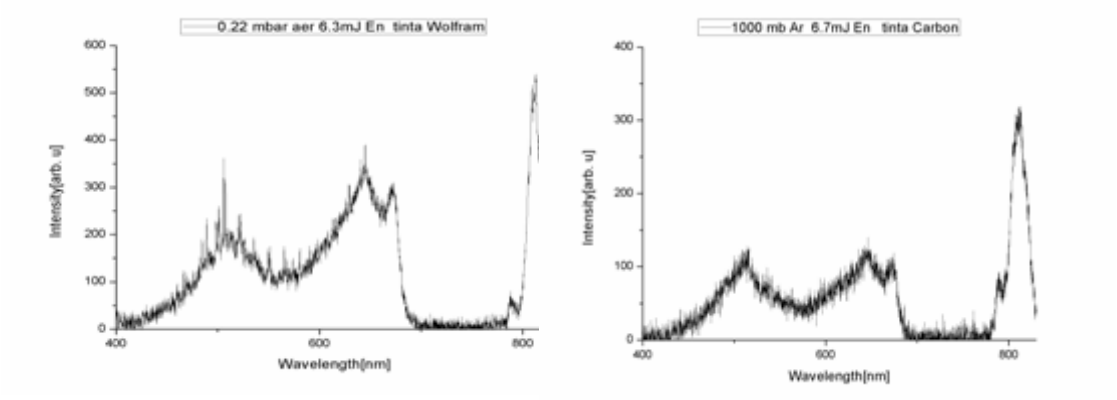

Fig.3 Emission spectra obtained during W and C irradiation

The morphology of the samples after irradiations was studied using Scanning Electron Microscopy (SEM)

Was used an apparatus produced by the company FEI : Inspect™ Scanning Electron Microscope". The impact craters are shown in Figs 4-6

Fig. 5 W irradiation effect

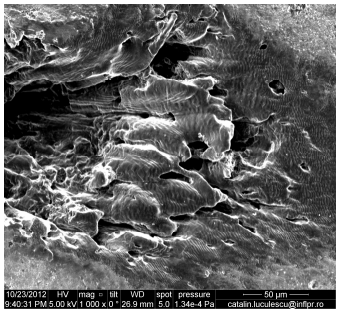

Fig. 6 C irradiation effect

Fig. 7 Be irradiation effect

Indirect laser irradiation (with the plasma produced by laser, very close to the target

The incident laser energy was about 7.5 mJ, with a duration of 70 fs, repetition rate of 10 Hz. The distance between the target and the plasma produced by laser was about 0.5 mm. We recorded the plasma emission spectra, shown in Fig.8

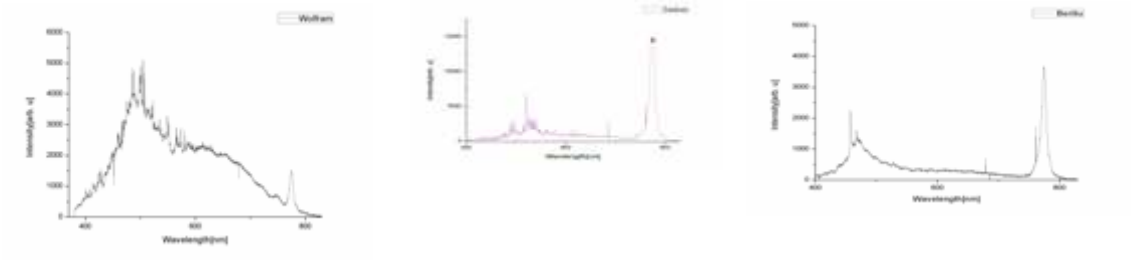

Fig.8 Emission spectra during indirect irradiation of W, C and Be

Using SEM analyses, was highlighted the effects of the indirect laser irradiation as shon in Fig.9-11

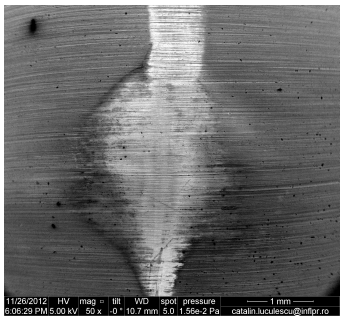

Fig. 9. The effect on W target

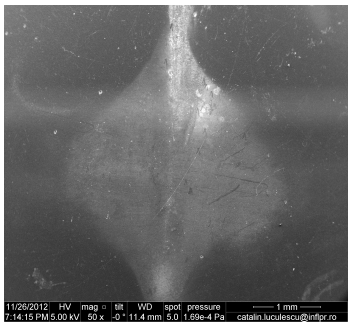

Fig.10 The effectof the C target

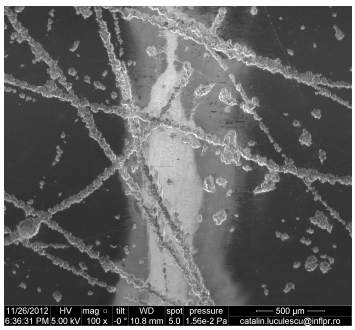

Fig.11 The effect of the Be target

XPS analyses

Chemical bond analyses formed after the laser irradiation was performed using an XPS (X-ray photelectron spectroscopy) device PHI-Quantera SXM model 2010using monochromatic Al Kα (hv 1486.6 eV) radiations emitted by an X ray source with Al anode and an electron energy analizer having an average radius of 300 mm and 0.65 eV rsolution. Figs 12-14 present the XPS general and core spectra of the interest elements

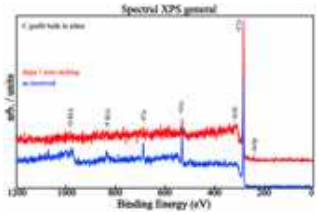

Fig.15 General XPS spectrum of C

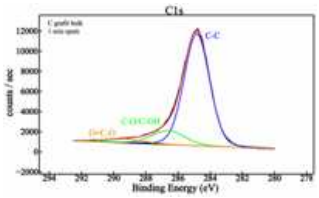

Fig. 16 Core spectrum of C1s

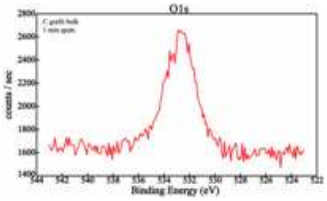

Fig 17 Core spectrum of O1s

We observed an important rise of the C signal after „in situ" etching of the sample using Ar ions at 1keV energy and scanning area of 2 mm x 2 mm. The relative noisy spectrum of the oxygen element suggest a relative small O concentration which is bonded to the C atoms. Also some OH bonding are highlighted. The other XPS spectra of the elements are presented below, highligthing the oxide formation durind the irradiations in air atmosphere. (Figs 15-20)

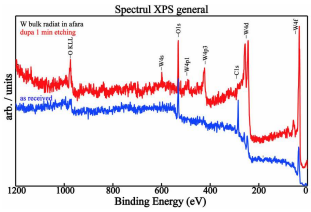

Fig.15 General XPS spectrum of W

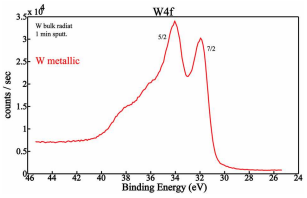

Fig. 16 Core spectrum of W4f

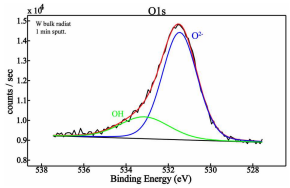

Fig 17 Core spectrum of O1s

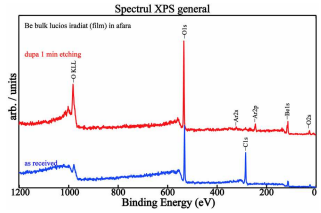

Fig.18 General XPS spectrum of Be

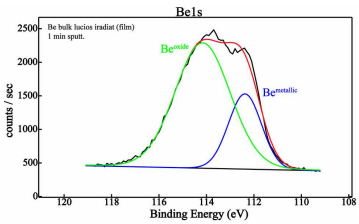

Fig. 19 Core spectrum of Be1s

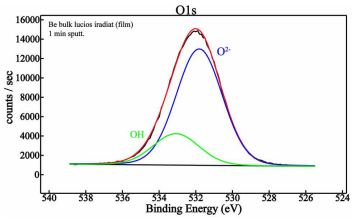

Fig 20 Core spectrum of O1s

In all XPS spectra deconvoluted, appears the O^{2-} component representing the O bonded in the network in the oxides formed on the surface due to the laser irradiation

The results diseminations:

2 papers published in iSI journals and 5 presentations to International conferences, Worksops and Summer Schools:

1. C. P. Lungu, A. Marcu, C. Porosnicu, I. Jepu, A. M. Lungu, P. Chiru, C. Luculescu, R. Banici, D. Ursescu, R. Dabu, I. D. Feraru, C. E. A. Grigorescu, G. Iacobescu, M. Osiac, J. Kovac, V. Nemanic, I. Hinkov, S. Farhat, A. Gicque, and O. Brinza, Terawatt laser system irradiation of carbon/tungsten bilayers, Phys. Status Solidi A, 1–6 (2012) /

DOI 10.1002/pssa.201200046, Physica status solidi, Article first published online: 17 SEP 2012

2. Lungu, C. P. ; Marcu, A. ; Porosnicu, C. ; Jepu, I. ; Kovac, J. ; Nemanic, V. Carbon–Tungsten Thin-Film Deposition by a Dual Thermionic Vacuum Arc, Plasma Science, IEEE Transactions on, DOI: 10.1109/TPS.2012.2218621, Date of Publication : 18 October 2012

Conferences:

1. Cristian P. LUNGU, Mixed films preparation using thermionic vacuum arc method, Lucrare invitata Varna 2012, Conferinta internationala: 17th International School on Condensed Matter Physics, September 2nd - September 7th, 2012, Varna, Bulgaria

2. C.P.Lungu, C. Porosnicu, I. Jepu, A. M. Lungu, P. Chiru, A. Marcu, C. Luculescu, R. Banici, D. Ursescu, R. Dabu, I. D. Feraru, C. E. A. Grigorescu, G. Iacobescu, M. Osiac, J. Kovač, V. Nemanič, I. Cadez , I. Hinkov, S. Farhat, A. Gicquel, O. Brinza and C. Focsa, Pulsed laser beam interaction with carbon, tungsten and beryllium coatings, Conferinta internationala "JVC-14/EVC-12/AMDVG-11/CroSloVM-19", 04-08 June 2012, Dubrovnik, Croatia

3. P.C. Lungu - Laser irradiation of materials for fusion devices, Natural Alternative & Sustainable Energy Systems Workshop, University of North Texas, 25-26 June 2012, Denton, USA, prezentare orala

4. Cristian P. LUNGU, Laser irradiation influence on the fusion devices materials, The 8th General Conference of Balkan Physical Union, 8th BPU, 5 – 7 July 2012, Constanta, Romania, lucrare invitata

5. C.P. Lungu, C. Porosnicu, I. Jepu, A. M. Lungu, P. Chiru, R. Banici, D. Ursescu, R. Dabu, I Feraru, C. E. A. Grigorescu, G. Iacobescu, M. Osiac, J. Kovac, V. Nemanic, Nanocomposite Tungsten-Carbon Film Formation by Terawatt Laser System Irradiation, E-MRS 2012 Spring Meeting, Strasbourg (France) May 14 to 18, 2012, poster.