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)

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In the frame of Stage 1: "C, W and Be coatings interaction with the pulsed laser beam in vacuum. Coatings characterization before and after laser beam interaction experiment", were performed deposition using thermionic vacuum arc method of a set of W and C layers. The deposition records and the characterization results are presented:

A. W deposition

Substrate: 4x graphite substrates of 12 mm x16 mm

5x silicon substrates of 12 mm x14 mm

The correction factor used to set the quartz monitor was calculated using the following formula:

$$f_{correction} = \left(\frac{d_{X-quartz}}{d_{X-probes}} \right)^2$$

Using the above formula and sample-cathode distance was obtained a 1.396 factor.

$d_{W\text{-}quartz}$ (cm)	$d_{W\text{-}probes}$ (cm)
26	**22**
f_W=1.396	

The coating were performed using the following parameters:

Nr.	U_a(kV)	I_a(A)	I_f(A)	P (Torr)	Thickness (nm)	Time (min)
1	0.75	1.9	42	$1.5x10^{-5}$	10	3
2	1.2	2	41	$1.4x10^{-5}$	30	12
3	1.2	2	41.5	$1.5x10^{-5}$	50	18
4	1.2	2	43	$1.2x10^{-5}$	100	33
5	1.4	1.9	44.5	$1.2x10^{-5}$	150	48
6	1.8	1.8	44.6	$9.6x10^{-6}$	180	57

$T_{substrate}=600^0C$

TOTAL deposition time = 64min

TOTAL thickness = 200nm

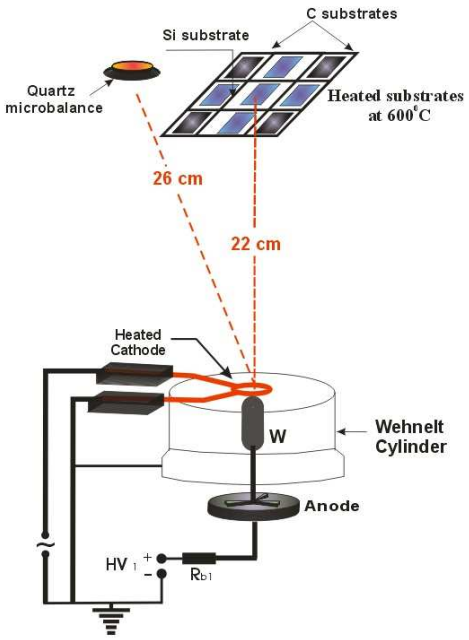

Fig.1 The set-up used for W deposition

B. C deposition

Substrate: 4x graphite 12x16 (the previous W coated substrates)

5x Si 12x15

$d_{C\text{-quartz}}$	$d_{C\text{-probes}}$

Quartz correction factor

$$f_{correction} = \left(\frac{d_{X-quartz}}{d_{X-probes}} \right)^2$$

(cm)	(cm)
25	**23**
f_W=1.18	

Deposition parameters:

Nr.	U_a(kV)	I_a(A)	I_f(A)	P (Torr)	Thickness (nm)	Time (min)
1	1.3	1.8	37	$1.5x10^{-5}$	100	-
2	1.5	1.8	37	$1.5x10^{-5}$	200	2
3	1.4	1.9	38.3	$1.5x10^{-5}$	500	6
4	1	2	38	$1.5x10^{-5}$	830	11
5	0.8	2.4	40	$1.5x10^{-5}$	1000	14
6	0.7	2.6	39	$1.5x10^{-5}$	1350	18
7	0.9	2.5	39.4	$1.5x10^{-5}$	1950	28

$T_{substrate}$=600^{0}C

TOTAL deposition time = 37min

TOTAL thickness = 2500 nm

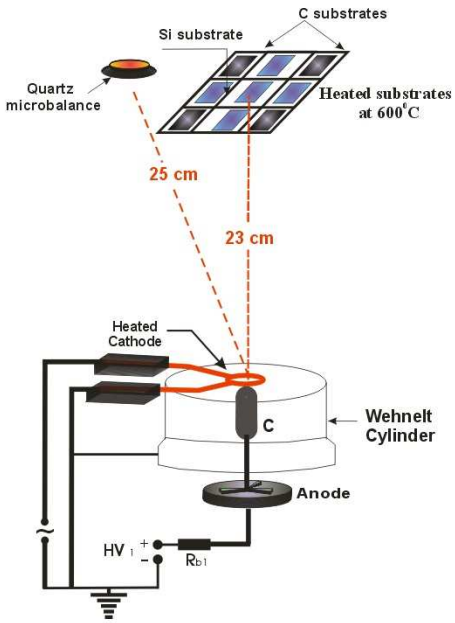

Fig.2 Carbon deposition set-up

The film structure is presented in Fig.3

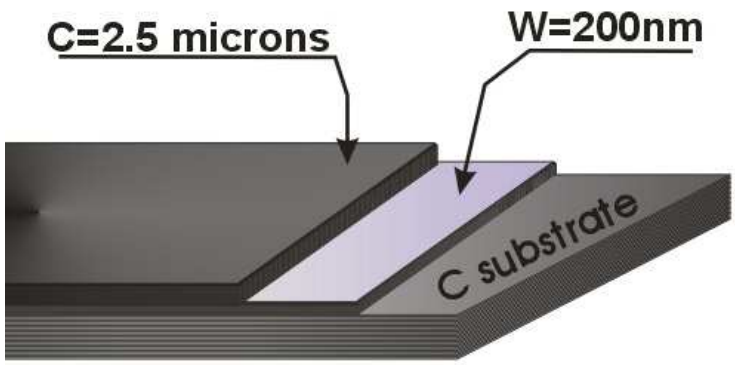

Fig.3 W+C multilayer thin film structure

D. Irradiation of the prepared samples: plasma plume emission spectra.

Using the terawatt laser system (Tewalas), 20-30 x 10^{-15} s pulse duration, 400-450 mJ pulse energy, were irradiated the prepared samples.

The spectra recorded in the 10-22 nm domain from 10 successive pulses in the same location on the sample.

Was observed that after 2 pulses appears the emission corresponding to the W element, and slowly disappear. (Fig.4)

Fig. 5 shows the emission in a zone where C lines does not exist, but only a cvasi continue W emission for all 10 successive pulses

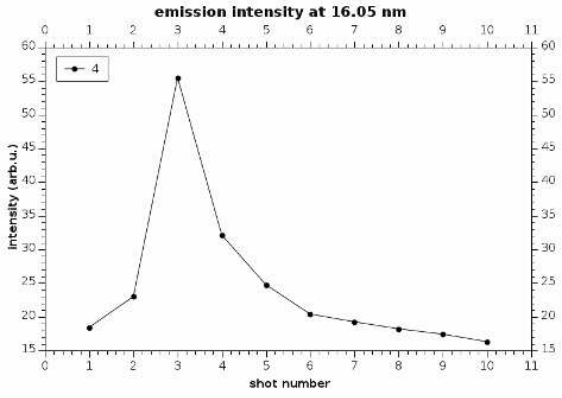

Fig. 4. Emission intensity of the W peak at 16.05 nm

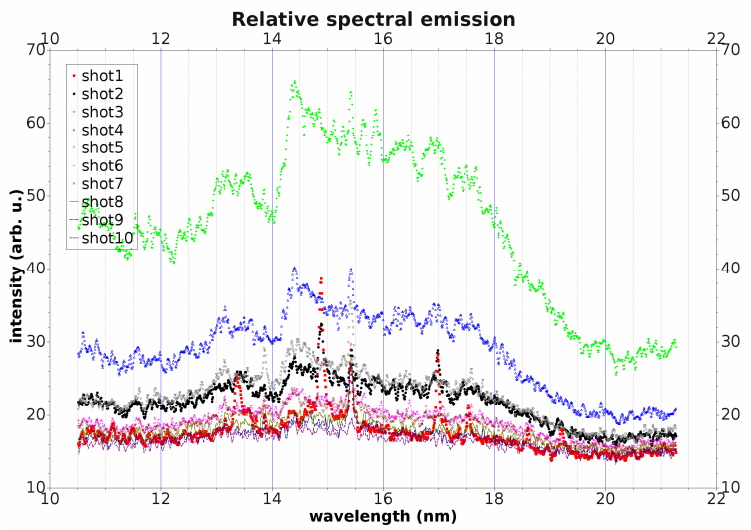

Fig.5 The emission spectra in the 10-22 nm range.

E. Optical microscopy investigation

Using a high resolution optical microscope, the wear produced by the laser shot is presented in Fig. 6

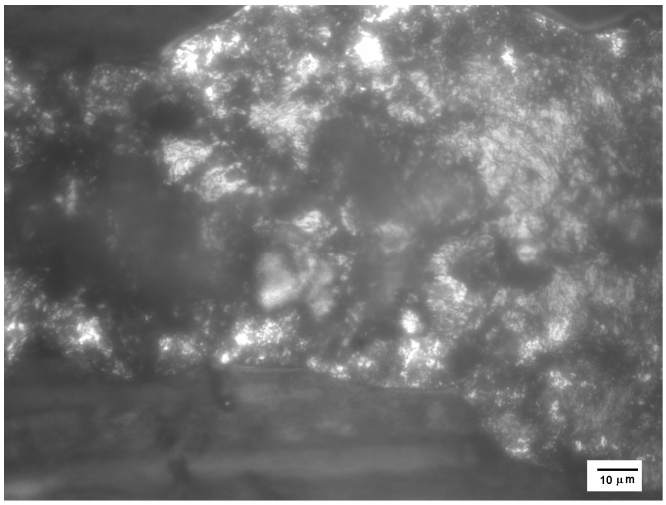

Fig.6. Wear produced by the laser shots on the prepared multilayer W – C film

Using SEM, EDS and Raman spectroscopy, the samples will be characterized further.

Project Director,

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