Publ. Astron. Obs. Belgrade No. 89 (2010), 139-141 *Contributed Paper*

THE INVESTIGATION OF TWO-PHASE PLASMA FLUXES OF SILVER

VICTOR GONCHAROV, KONSTANTIN KOZADAEV
and DMITRIY SHCHEGRIKOVICH
Belarusian State University,
7 Kurchatov str, 220108 Minsk, Belarus
E-mail: kozadaeff@mail.ru

Abstract. We propose to use a laser probing method for research of laser-induced silver plasma fluxes (laser jets). As a result the fact of drop-liquid phase presence at that plasma formations is established. Due to time resolution of laser probing method we measured the dynamics of particle sizes and concentration of condensed phase of silver at erosion jets.

1. INTRODUCTION

At the present time the incremental practice interest consists in the development of method of silver-nanoparticle emulsification, which is based on getting of liquid droplet phase of erosive laser jets of metals into aquatic environment by intensive laser action. Generic aspect of this method is that erosion process elapses in environment of erosion laser plasma.

For realization of such method of metal nanoparticles forming it's necessary to research the behaviour of condensed phase of metal in erosive laser jet in sufficient spread-spectrum of densities of influence impulse power (10^8-10^9 W/cm^2), and to study separation capability of primary nanodimensional particles of metallic target material.

2. EXPERIMENT

The main method of research in this work is the method of laser probing of optically transparent objects that containing the superdispersed phase of metal. This method has a number of advantages. First of all, it allows to determine the parameters of particles of metal condensed phase in real time. Secondly, it is the nondestructing control method. Thirdly, it isn't requiring special preparation of samples under test.

Method of laser probing is based on the registration of incident, propagated and scattered radiation during interaction with particles of liquid drop phase of plume. It enables real-time control of size and concentration of fine-dispersed phase with characteristic time of plasma processes ~ 10^{-6} sec.

Thus during the experiments for the investigation of processes that occur in the laser erosion plumes of the metal targets it is necessary to automatically control and process of four time dependences of intensity of effecting radiation, intensity of incident probing radiation, intensity of propagating part of probing radiation and intensity of scattered radiation.

For computer-aided processing of registration results the program ‘Plasmameter’ is used that was specially worked out for such goals. Corresponding parameters are obtained for every spike of probing radiation and diameter and concentration of particles are calculated in the moment of spike generation. As a result of experimental data full analysis curves for the diameter and concentaration of particles are established.

3. RESULTS

As a result of the carriing out of the investigation of the unteraction of powerful laser impulse radiation of submicrosecond duration with silver targets the presence of significant quantity of the nanodimensional silver particles (40 – 50 nm depending on the experiment conditions) was determined in the nearsurface region of the target in the forming erosion laser plume. In contrast to laser erosion by long-term laser pulses (10 µs – 10 ms) submicrosecond pulses mode has few features:

1. The main mechanism of liquid-drop phase particles forming for the defined conditions of laser impact is condensation from the plasma vapor of the erosion plume. Particles formed in the erosion laser plume attend in the nearsurface region of the target long time after laser impact (till 500 – 600 µs after impact).

2. During all the probing time particles of the target material condensed phase are of the nanometer size. This fact makes regime under study suitable for the metallic nanostructure forming because of the absence in the plume particles of another size range.

3. Roughness of the target surface renders significant influence on the efficiency of the liquid-drop phase of the metal formation. The effect of target relief smoothing during repetitive pulses is noticed that impose some constraints on the frequency laser using for the given mode of impact. For the support of the high efficiency of the frequency modes of the metal treatment it is required to provide continuous change of the radition focus spot location that impacts on the target surface.

The characteristics of the silver nanodimensional phase and some thermophysical properties of silver as a metal are in the table:

Table 1. The characteristics of the silver nanodimensional phase and thermophysical properties of silver.

Power density of the influence radiation 10^8 W/cm^2		Power density of the influence radiation 10^9 W/cm^2		Melting temperature, °C	Vaporization temperature, °C	Specific heat of evaporation, kJ/mole	Reflection coefficient, % λ=1000 nm
d, nm	N, cm^{-3}	d, nm	N, cm^{-3}				
40	$7 \cdot 10^{12}$	35	$3 \cdot 10^{13}$	962	2170	266	97

References

Goncharov, V. K., Ismailov, D. F., Kozadaev, K. V., Puzyrev, M. V.: 2007, *Optical memory and Neural Networks*, , **16,** 254.

Goncharov, V. K., Kozadaev, K. V.: 2010, *Journal of Engineering Physics and Thermophysics,* **83**, 80.

Goncharov, V. K.,, Kozadaev, K. V.,, Puzyrev, M. V.,, Stetsik, V. M.: 2009, *Journal of Engineering Physics and Thermophysics*, **82,** 638.