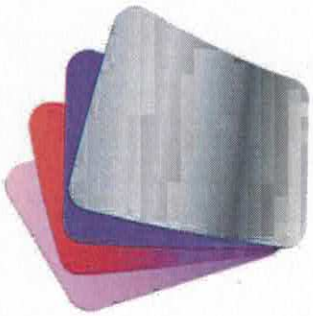

PLATHINIUM

PLASMA THIN FILM INTERNATIONAL UNION MEETING

Abstract book

11 - 15 September 2023 - Antibes, French Riviera

www.plathinium.com

NANO-P2-029 • Creation of pure and homogenous carbon nanoparticles from laser-induced carbon vapors

A. Kaczmarek [1], J. Hoffman [1]
[1] *Department of Experimental Mechanics, Institute of Fundamental Technological Research Polish Academy of Sciences, Warsaw, Poland*

Usually, the synthesis of nanoparticles by means of Pulsed Laser Ablation in Liquids (PLAL) is perceived as a bottom-up approach, since laser – target interaction results in melting, evaporation, ionization and nucleation of atoms to further form nanoparticles. This mechanism of particles formation can be summarized by the term 'condensation of laser-induced vapor'. However, there are several other mechanisms leading towards nanoparticles creation due to ejection of liquid droplets as an effect of so called phase explosion and explosive boiling [1,2]. Nevertheless, aforementioned mechanisms can be accompanied by a top-down process, namely: laser exfoliation of the target. As the result, in the case of graphite target ablation, both carbon nanoparticles and graphene-like nanosheets can be obtained. Thus, the resultant colloidal suspension is inhomogeneous both in terms of size and structure [1]. Thereupon, determination of colloid properties, such as luminescence behavior and activation mechanism, is strongly compromised. Therefore, it is crucial to establish synthesis conditions and parameters favoring the production of one type of nanostructures only.
Even though aforementioned processes of nanoparticles production have been analyzed [3], presented data involve the creation and evolution of cavitation bubble, namely – relatively long periods of time (tens of microseconds) after laser pulse.
The premise of the following work is to analyze PLAL processes during first microseconds after laser pulse in terms of carbon nanoparticles production. Hence, theoretical reasoning for formation resulting from condensation from vapor is provided. Also, experimental confirmation of the reasoning is provided, that is homogenous carbon nanoparticles of 3-5 nm, which structure no longer mimics the structure of the target (Fig. 1).

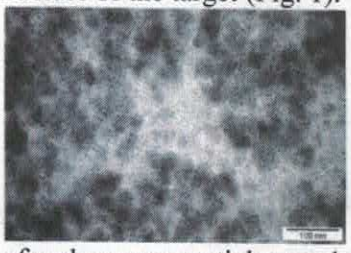

Fig.1. TEM image of carbon nanoparticles produced in experiment.

References:

[1] Altuwirqi, R.M. Graphene Nanostructures by Pulsed Laser Ablation in Liquids: A Review, Materials, 2022, 15, 5925
[2] Kaczmarek A., Hoffman J., The best conditions for the nucleation of carbon nanoparticles in laser-induced plasma, Nanotechnology, 2022, 33, 355602
[3] Dell'Aglio M., Gaudiuso R., De Pascale O., De Giacomo A., Mechanisms and processes of pulsed laser ablation in liquids during nanoparticle production, Applied Surface Science, 2015, 348, 4-9