INVESTIGATION OF LOW-DENSITY NANOSTRUCTURED MATERIALS FOR LASER TARGETS BASED ON POLYMER NETWORKS OF ACENAPHTHYLENE, ALPHA-METHYLSTYRENE AND CHITOSAN [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2023.50.2023.1.1.099

Pastukhov A.V., Akunets A.A., Pervakov K.S., Kuvshinov I.R., Gromov A.I., Mordvintsev I.M., Puzyrev V.N., Rupasov A.A., Sahakyan A.T., Borisenko N.G.

P.N. Lebedev Physical Institute, Russian Academy of Sciences, Moscow, Russia, [avpast@gmail.com](mailto:avpast@gmail.com)

The study of the interaction of high-power laser radiation with nanostructured materials is an urgent task for fundamental science and for the future Russian clean energetic. The purpose of this work is to obtain new low-density polymer targets, to study their porous structure, and to see their functioning under powerful laser irradiation. Low-density polymeric materials were obtained based on synthesized hypercrosslinked polymers of alpha-methylstyrene (PAMS) and on acenaphthylene produced using a bis-chloromethyl derivative of diphenyl [1, 2]. Synthesis of PAMS was carried out by the method of cationic polymerization at -70°C, whereas polyacenaphthylene was synthesized by the method of thermal radical polymerization of acenaphthylene. Using gel permeation chromatography, it was found that the samples of the obtained linear polymers have a wide distribution in molecular weights from 104 to 106 with maxima 4.4\*105 and 3.6\*104. Low densities from 30–60 to 160–180 mg/cm3 were realized by freeze drying the crosslinked chitosan hydrogels and by supercritical drying the hypercrosslinked polymer organogels in carbon dioxide. To determine the parameters of the porous structure, we used measurement data on nitrogen sorption at 77 K (sorption isotherms). The calculations were carried out for a cylindrical pore model by the BJH (capillary condensation theory) and DFT (density functional theory, quenched solid density functional theory) methods [3]. Samples of hypercrosslinked polyacenaphthylene have the most developed system of micropores 2–3.5 nm in size. The specific surface area of the pores of this polymer reaches 1800 m2/g, and their total volume is 5.5 cm3/g (pores up to 140 nm). The porous structure of the obtained polymers was found to have three fractions of pores, 2–3.5 nm, 3.5–5 nm, and 10–30 nm in size. Depending on the type of the initial linear polymer, the volume fraction of the 1st, 2nd, and 3rd groups of pores in the samples dried in carbon dioxide can reach 20, 10, and 65% of the total volume of pores 2–50 nm in size. Studying chitosan-based low-density materials by the method of low-temperature nitrogen sorption, no micro and mesopores were found in the range less than 50 nm.

In the P.N. Lebedev Physical Institute of the Russian academy of sciences (LPI) the first experiments on the laser irradiation of the considered low-density targets were carried out on the KANAL-2 facility. The authors acknowledge New Scientific Group-55 support from LPI.

References

1. Davankov V.A., Tsyurupa M.P. Hypercrosslinked Polymeric Networks and Adsorbing Materials. Еlsevier, Amsterdam, Boston, etc., 2011, 670 р.
2. Pastukhov A.V., Akunets A.A., Borisenko N.G. A method for producing low-density super-crosslinked polymers of a monolithic type. Russian patent IZ No. 2738607 C1, 12/14/2020 (BI No. 35, 2020).
3. Lowell S., Shields J.E., Thomas M.A., Thommes M. Characterization of Porous Solids and Powders: Surface Area, Pore Size, and Density, Springer, 2004, 347 p.

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/It/ru/DS-Pastukhov.docx) [↑](#footnote-ref-1)