POROUS STRUCtURE OF LOW-DENSITY HYPERCROSSLINKED POLYMERIC mesheS – candidate MATERIALS FOR LASER TARGETS

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Investigations in the field of high energy physics are currently of high importance for both the fundamental science and energy generation in Russia. From this point of view, particularly actual appears examining the interaction of high energy laser beams with materials of various structures. Studies of low density media subjected to the action of high intensity laser irradiation showed a strong dependence of the absorption and wave propagation on the structure of the target, specifically on the pore size and pore size distribution. In connection with these findings, present investigation aims at obtaining new types of low density polymeric materials and investigating their porous structure. Starting from linear polymers of styrene [1] and alpha-methylstyrene, hypercrosslinked polymeric networks have been synthesized by using bis-chloromethyl derivatives of benzene and biphenyl. The crosslinking reaction of polymers catalyzed by thin tetrachloride was conducted in polymer solutions of low concentration (1–2%) in ethylene dichloride. The analysis of the porous structure of synthesized polymeric networks was done with the use of low temperature nitrogen adsorption technique with data processing according to the both BJH (theory of capillary condensation) and DFT (density functional theory) [2]. The BJH-analysis of the porous structure of hypercrosslinked poly(alpha-methyl styrene) showed that the most developed system of micropores having diameters of 3 to 6 nm exhibit xerogels of polymer networks crosslinked to an extent of 300%. Pore structure evaluations according to DFT theory allowed revealing two modes of micropores in the polymers synthesized, namely in the diameter ranges of 1.8–3.0 nm and   
4.0–10 nm. Evaluation of the porosity parameters of the networks according to DFT theory and cylindrical pore model involved two variants of approaches – one based on the standard non-local density functional theory (NLDFT), the other – on the method of quenched solid density functional theory (QSDFT) based on carbon equilibrium transition kernel at 77 K. Hypercrosslinked poly(alpha-methylstyrene) networks, synthesized in a 1% solution of the polymer and crosslinked with bis-chloromethyl-diphenyl (degree of crosslinking as high as 100 to 300%) are highly porous polymeric networks displaying specific inner surface area up to 900 m2/g, they are capable of increasing their volume several times by swelling in both organic solvents and water. Such swollen polymeric materials – organogels incorporate large amounts of the liquid phase, in particular benzene, up to 20 cm3/g. Organogels of hypercrosslinked polystyrene networks obtained at higher solution concentrations of 2 and 9% incorporate 13 and 3.5 cm3/g toluene, respectively. It was further found that increasing their crosslinking density from 100 to 300% results in an increase in total specific surface area by a factor of two. The total volume of micro- and mesopores of synthesized polymers amounts to 1.1 cm3/g (when judged on the amount of nitrogen adsorption at relative pressure P/Po = 0.98, 77K). Partly supported by RFBR №17-02-00366.

References

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