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FEATURES OF THE PLASMA-POLYMERIZED COATINGS CHEMICAL COMPOSITION FORMATION BY THE MONOMER INJECTION INTO DIFFERENT REGIONS OF A GLOW DISCHARGE *

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The polymerization of organic substances using gas discharge plasma is currently being actively studied, due to the fact that polymer coatings obtained by this method can be widely used. In particular, we have shown that such coatings can be used as protective dielectric layers for electronics [1, 2]. It is known that the chemical structure and composition of polymer coatings determine the physical and operational properties of coatings [3, 4]. Despite this, the mechanisms of plasma-chemical processes leading to the formation of the chemical structure of coatings have not been adequately studied [5].

In this paper, we consider the features of the formation of the chemical structure of polymeric organosilicon coatings deposited using a plasma-chemical reactor based on a low-pressure glow discharge in a carrier gas/monomer mixture flow. Plasma chemical reactor is a gas-discharge system containing two hollow coaxial electrodes. A DC source was used to ignite and maintain the discharge in the current range from 5 to 70 mA. [6]. Argon and hexamethyldisiloxane (HMDSO) were used as carrier gas and monomer, respectively. Argon at a flow rate of 230 mg/min was injected into the plasma-chemical reactor through the cathode hollow. HMDSO was mixed with argon and injected into the reactor through the cathode hollow (pre-mixing) or injected into the reactor into the region of the positive plasma column through the side tap of the plasma-chemical reactor (mixing in the region of the positive column).

The elemental composition and chemical structure of polymer coatings obtained with different supply of monomer to the plasma-chemical reactor are considered. The study of the chemical structure and composition of the coatings was carried out using infrared spectroscopy and X-ray photoelectron spectroscopy. It is shown that during premixing, the C/Si ratio changes from 1 to 7.5 with increasing discharge power. In the case when mixing occurs in the region of the positive column, the C/Si ratio corresponds to ~ 1, regardless of the variation in the discharge power. It has also been shown that 30-50% (depending on the power consumption of the discharge) of carbon atoms in coatings obtained using pre-mixing are subject to oxidation. The features of the chemical structure formation and composition of the obtained coatings can be explained by considering the differences in conditions in different regions of the glow discharge plasma. The mechanisms of plasma-chemical processes occurring in different regions of the glow discharge plasma are proposed. In particular, the formation of hydrogenated carbon in the cathode layers of the discharge, and the formation of mono- and bi-radicals in the positive column of the glow discharge are considered.

REFERENCES

[1] D. Zuza, A. Batrakov, V. Nekhoroshev, I. Kurzina and S. Popov, "Plasma-Assisted Deposition of Dielectric Conformal Coating Using Hexamethyldisiloxane as Precursor," *2020 7th International Congress on Energy Fluxes and Radiation Effects (EFRE)*, 2020, pp. 1132-1135.

[2] A. V. Batrakov, S. A. Popov, K. V. Karlik, E. L. Dubrovskaya, A. V. Schneider, I. Kurzina, S. B. Suntsov, A. V. Seloustev, A. A. Hvalko, "Suppression of Prebreakdown Emission Activity Inside the On-board Spacecraft Equipment by Local Polymerization in Discharge", *Proc. 28th Int. Symposium on Discharges and Electrical Insulation in Vacuum (ISDEIV)*, vol. 2, pp. 777-780, 2018

[3] G. Dakroub, T. Duguet, J. Esvan, C. Lacaze-Dufaure, S. Roualdes, V. Rouessac, "Comparative study of bulk and surface compositions of plasma polymerized organosilicon thin films," Surfaces and Interfaces, vol. 25, 101256, 2021.

[4] L. Kleines, S. Wilski, P. Alizadeh, J. Rubner, M. Wessling, C. Hopmann, R. Dahlmann, "Structure and gas separation properties of ultra-smooth PE-CVD silicon organic coated composite membranes," Surface and Coatings Technology, vol. 421, 127338, 2021.

[5] D. Hegemann, E. Bülbül, B. Hanselmann, U. Schütz, M. Amberg, S. Gaiser, "Plasma polymerization of hexamethyldisiloxane: Revisited," Plasma Process Polym., vol. 18, no. 2, 2000176, 2021.

[6] Korolev, Yu. D. , Nekhoroshev, V. O. ;Frants, O. B. ; Bolotov, A. V. ; Landl, N. V. "Power Supply for Generation of Low-Temperature Plasma Jets," Russian Physics Journal, vol. 62, no 11, pp. 2052-2058, 2020.

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