ANALYSIS OF THE NITROGEN PLASMA JET DESTRUCTIVE EFFECT ON THE HEAT-RESISTANT MATERIALS

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Processes of heat and mass transfer in the interaction zone of a high-temperature subsonic plasma stream with the surface of a ablating heat-resistant material determine the rate of its destruction [1–4]. Intensive work is being carried out to create and study new heat-shielding materials based on composites (SiC/C, HfB_2–SiC, etc.), and the mechanisms of their destruction under the influence of high-temperature and chemically active media are studied in detail [2–4]. The purpose of this study is to establish changes in the parameters and composition of the plasma in the destructive interaction zone of an incident high-enthalpy nitrogen plasma jet and samples from carbon-containing materials. The complex [4] created in the JIHT RAS provides the possibility for creating and studying the plasma of various gases (Ar, He, N_2, air) and their mixtures over a wide range of temperatures (T=10–30 kK), mass flows 0.2–5 g/s and velocities of 50–1000 m/s in the output section of the plasma torches. An experimental estimate of the mass loss rate of the sample material in real time is performed by the methods of two-position high-speed video imaging and the method of laser profilometry developed by the authors using a "laser knife" [5]. The studies used isotropic MPG-6 graphite with a cylindrical shape and density of $\rho \approx$1.70–1.8 g/cm^3, and anisotropic graphite UPV-1T with a density of $\rho \approx$2.1–2.2 g/cm^3 in the form of a parallelepiped with a characteristic thickness of 3–5 mm and a side of 15–25 mm.

At specific thermal loads of 1-2 kW/cm^2, experimental data revealed spatial-temporal changes in the samples materials decrease rate (3-20 mg/cm^{2}s), their surface temperature (2000–3500 K), the electron temperature of the incident plasma stream (12000–6000 K), plasmochemical composition in the region of "injection" of the products of destruction.

A joint analysis of the spatial-temporal variations in the concentration of the main destruction byproducts, carbon atoms and the CN radical, and the rate of loss of the carbon-containing sample material, makes it possible to establish the relative role of the processes of heterogeneous (C_{solid} + N $\rightarrow$ CN) and homogeneous (C_{gas} + N + M $\rightarrow$ CN + M) carbon nitrization in the interaction zone.

The work is carried out with the partial support of the Russian Foundation for Basic Research on grants No 16-08-00323 and No 17-08-00816.

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