SYNTHESIS OF NITROGEN OXIDES IN THE Subthreshold MICROWAVE (SNSs) DISCHARGE IN AIR AND IN ITS MIXTURE WITH METHANE

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The nonlinear stage of the ionization-overheating instability [1] with the formation of filaments in the plasma of the SNSS discharge ends with an explosive process of increasing the temperature of electrons, heavy particles, and plasma density. This causes complete dissociation of molecules in the filaments and their gas-dynamic expansion. The result of this process is the rapid cooling of the expansion products behind the discharge head, i.e. the emergence of an efficient hardening process for the synthesis of new compounds.

The experiments were performed using a plasma-chemical reactor [2], with the discharge initiated by a Gaussian beam of a gyrotron (4 mm wavelength) at a power of 120 and 240 kW.

In the first experiment, the reactor was filled with air. To create a discharge, packs of 4 pulses with a duration of ~1.8 and ~0.7 ms with an interval between pulses of ~20 ms were used. The velocity of the discharge front was measured by the location method [3]. The composition of the gas mixture after treatment with a series of discharges was measured using an «FSM-2202» Fourier transform infrared spectrometer.

It was found that as the average specific energy input increases, the average concentration of the sum of all oxides of nitrogen grows in the reactor volume. At the same time, up to 50% of oxygen is consumed for their formation. The maximum specific energy input reached 16 J/cm3 with an average specific energy input on a single discharge trajectory of ~0.4 J/cm3.

In the second experiment, the reactor was filled with a mixture of methane (150 Torr) with air (610 Torr), the discharge was initiated by a single pulse. In the subsequent after the first discharge, no noticeable formation of nitrogen oxides was registered. This indicates the competitive role of processes involving methane in the formation of nitrogen oxides.

Simulation of the synthesis of nitrogen oxides by a kinetic scheme similar to that used in [4] demonstrated that the simulation results agree with the results of measurements in the absence of methane.

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References

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