INFLUENCE OF THE COMPOSITION OF THE GAS PHASE IN THE PLASMA JET OF A DC PLASMA TORCH ON THE PROPERTIES OF GRAPHENE [[1]](#footnote-1)\*)

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A wide range of graphene properties (high mobility of charge carriers, high thermal conductivity, chemical stability, mechanical rigidity) is due to the degree of imperfection of a two-dimensional crystal, which depends on the presence of intrinsic defects in the crystal lattice and/or impurity defects in the form of foreign atoms. There are: hydrogenated graphene, deformed due to the addition of hydrogen in certain areas of graphene; graphene doped with nitrogen atoms; oxidized graphene (containing oxygen groups), differing in their properties and applications.

This paper presents the results of a study of the plasma-chemical synthesis of graphene in bulk during the pyrolysis of hydrocarbons in plasma jets of a DC plasma torch with a power of up to 45 kW. It was found that using a mixture of helium with the addition of a propane-butane mixture, the maximum yield of graphene containing hydrogen in a ratio of 1:4 to carbon is achieved. If acetylene is added to nitrogen, the nitrogen-containing graphene is formed in the plasma jet at a pressure of 100 Torr. When methane is introduced into an argon plasma at a pressure 350 Torr in the reactor, at the outlet low-defect nanostructures are formed with a lateral size of up to 2000 nm, which far exceeds their size during synthesis under other conditions. According to the study by scanning electron microscopy, in all cases the shape of the nanostructures is flaky, i.e. bulk synthesis leads to the formation of a deformed graphene sheet [1]. In addition, the elemental analysis shows, that nanostructures differ in the presence of different foreign atoms and in different amounts, which leads to different degrees of imperfection, and this is confirmed by the Raman spectra analysis.

It is known that during the pyrolysis of hydrocarbons, the main products of the process are soot, acetylene, hydrogen, divinyl, ethylene, ethane and benzene, and the factors influencing their formation are: feedstock; temperature; contact time and pressure [2]. In the experiment, the initial hydrocarbons differ in molecular mass and structure, but the plasma conditions ensure a high degree of their dissociation. The pressure values in the reactor are close. Thus, in the decomposition of hydrocarbons using a DC plasma torch, the main factor affecting the difference in the composition of gas-phase components is the time of the impact of high temperatures. Based on the created reactor model [3], temperature profiles were obtained for each composition, differing in the rate of temperature decrease. Obviously, this will lead to different time intervals of impact, and, consequently, to different conditions for the formation of the graphene crystal structure.

Thus, a correlation between the composition of the gas phase and the degree of imperfection of the graphene structure has been established experimentally and by modeling.

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References

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2. Shurupov S.V. Gas chemistry, 2009, 5 (9), 64 (in Russian).
3. Shavelkina M.B. et al. J Phys D Appl Phys., 2019, 52, 495202.
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Pt/ru/GB-Shavelkina.docx) [↑](#footnote-ref-1)