SPECTRAL DETERMINATION OF THE PLASMA PARAMETERS OF DISCHARGE INITIATED IN POWDER MIXTURES BY RADIATION PULSES OF A POWERFUL GYROTRON [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2023.50.2023.1.1.204

Letunov A.A., Knyazev A.V., Logvinenko V.P., Voronova E.V., Kharlachev D.E.

Prokhorov General Physics Institute of the Russian Academy of Sciences, Moscow, 119991 Russia, let@fpl.gpi.ru

The report presents the results of optical measurements in experiments on the synthesis of micro and nanoparticles with a controlled composition and structure based on a microwave discharge. The discharges were initiated by radiation pulses from a powerful gyrotron in thin layers of powder mixtures with a free upper surface. We used gyrotron radiation with a wavelength of 4 mm, a duration of 1 to 8 ms, and a power of 100–500 kW. In some experiments, additional ultraviolet initiation was used from a wire target placed above the powder, which made it possible to obtain a stable breakdown of mixtures both with a small amount of metal and sometimes with purely dielectric ones. Up to 7 spectral instruments with different resolutions were used simultaneously. Spectra were recorded when light was collected from the lower and upper surfaces of the powder layer and at a certain height along the layer with a height of the light-collection axis above the substrate of ~2.5 cm.

As a result of the use of both high-resolution spectral instruments (M833, manufactured by SOLAR LS and modified VMS-1), and AvaSpec survey spectrometers with a higher spectral resolution than before, more detailed characteristics of the discharge plasma of the type under study were obtained. In particular, lines of the titanium ion were found. In addition, in discharges with a mixture of powders containing 10% Pt, platinum lines that were previously masked by impurity lines, a continuous background, and noise were found.

The expansion of the composition of powder mixtures and the modification of the discharge regimes made it possible to reveal the conditions under which a high intensity of the emission of the H a line of the Balmer series of hydrogen was detected. As a result, the local electron density was reliably estimated. It is units per 1020 m-3. The characteristic value of the electron temperature measured from the lines of titanium and aluminum atoms [1], as before, was ~0.5 eV. The characteristic value of the Debye radius calculated from these results is ~30 μm, only slightly larger than the average particle size of powder mixtures.

The obtained results help us to understand the physics of the discharges of the investigated type and are necessary for successful modeling of the processes occurring in them.

The work was done on the state task of the State Enterprise BV10-2022 "Research on the innovative synthesis of micro- and nanoparticles with a controlled composition and structure based on microwave discharge in gyrotron radiation".

References

1. Knyazev A.V., Letunov A.A., Voronova E.V., Logvinenko V.P., in XLIX International Zvenigorod Conference on Plasma Physics and Controlled Fusion, Zvenigorod, 2022, Book of Abstracts, p. 202, DOI: 10.34854/ICPAF.2022.49.1.162
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Pt/ru/GY-Letunov.docx) [↑](#footnote-ref-1)