CURRENT LAYERS AND FRACTALS IN THE ARC PLASMA

Smolanov N.A.

Ogarev Mordovia State University, Saransk, Russia, [smolanovna@yandex.ru](mailto:smolanovna@yandex.ru)

The purpose of this work is to find the conditions under which fractal structures can form in an arc discharge plasma. In analyzing the fractal structures of particles, the main attention in this paper is paid to both the field and particle components of the plasma.

The analysis of processes in the vacuum arc plasma, which can affect the formation and growth of fractal structures, is carried out. The analysis is based on the fundamental theoretical and experimental results of magnetic hydrodynamics (plasma dynamics). It is shown that the theory of fractal acquires a major role in explaining the collective behavior of complex systems.

Ion-plasma methods are one of the methods for obtaining nanostructures. The study of processes in plasma by Langmuir probes is not able to resolve the spatial distribution of the potentials of the magnetic and electric fields within the limits of the nanoscale particles formed in the plasma. The conditions of the processes, including plasma-chemical, largely depends on the coordinate (location) in the chamber. You should also consider the current density within the area where different directions of currents are possible. The paper presents a review of the results of studying structures from an arc plasma deposited in the interelectrode space. An integrated approach to the study of processes in the plasma and the structures formed from it was made in [1]. Particular attention is paid to the 2 nd moments: "... the creation of plasma and its death on the walls of the working volume" [2, p. 12]. Our results of the study of the dispersed system of microparticles by the method of small-angle X-ray scattering showed that the main contribution to the scattering is made by particles that can be attributed to mass fractals with a dimension of 2.62 [3–5].

It is established that the fractality of particles is due to the conditions of formation of dispersed particles, the composition of the plasma flow, the parameters of the electric and magnetic fields in the interelectrode space. Typically, the formation of fractal-like aggregates occurs under conditions of instability of the growth front, and the growth of fractals is accompanied by high energy dissipation rates [6]. Where can such conditions exist in our case? An assumption (hypothesis) emerged that a part of the precipitated particles from the arc discharge plasma due to its unusual structure (fractal) is due to the current layers. In this paper, we analyzed the conditions for the appearance of current sheets (TS), their parameters and manifestations on a large scale - from cosmic plasma to laboratory plasma [7–10]. In the plasma flow of a vacuum arc, two processes involving current layers are possible, one of which leads to the formation of fractals.

References

1. Smolanov N.A., et al // Surface. 2015, № 4, p. 72–76.
2. Morozov A.I. Introduction to plasma dynamics. M .: FIZMATLIT, 2008. 616 p.
3. Smolanov NA, Neverov V.A. // Letters on materials, 5 (2), 2015, p. 179–184.
4. Smolanov N.A. // Journal of Surface Investigation 2017, 11 (2), p. 353–560.
5. Smolanov N.A. // Journal of Surface Investigation 2018, 12 (3), p. 593–597.
6. Anders A. Cathodic Arcs: From Fractal Spots ... Berckley: Springer Science, 2008. 540 p.
7. Frank A. G. //UFN 180 982–988 (2010).
8. Ledentsov L. S., Somov B. V. // UFN 185 113–142 (2015).
9. Budaev V.P., Khimchenko L.N. Fractal Grown in Tokamak: Preprint IAE-6404/7. – M., 2006.
10. Podgorny IM, Podgorny A.I. Physics of solar flares. Tez. report XLV Zvenig. conf. by nat. plasma and TCB. Zvenigorod, April 2–6, 2018 – Moscow: CJSC STC "PLAZMAIOFAN", 2018. p. 187.