

Effect of ionization on void formation in an RF discharge under microgravity conditions

L. M. Vasilyak, S. P. Vetchinin, D. N. Polyakov

Joint Institute for High Temperatures of Russian Academy of Sciences
Bld. 2, 13 Izhorskaya str., Moscow, 125412, Russia
E-mail: vasilyak@ihed.ras.ru

Received September 25, 2022

An analysis of the formation of a void in the PK3 setup in a dusty plasma with melamine-formaldehyde particles 3.4 μm in diameter in an RF discharge in argon at a pressure of 12–50 Pa under microgravity conditions on the ISS is presented. The uniform state of the plasma can only be obtained at a voltage close to the discharge extinction voltage. The application of a low-frequency voltage of 20–50 Hz stabilizes the state of the dusty plasma and shifts the void formation threshold towards higher RF voltages. It is shown that the formation of a void is associated with non-local ionization of the plasma at the center of the discharge by fast electrons, which are heated in the near-electrode layers.

Keywords: dusty plasma, void, RF discharge, microgravity.

DOI: 10.51368/1996-0948-2022-5-11-18

REFERENCES

1. A. G. Khrapak, V. I. Molotkov, A. M. Lipaev, D. I. Zhukhovitskii, V. N. Naumkin, V. E. Fortov, O. F. Petrov, H. M. Thomas, S. A. Khrapak, P. Huber, A. Ivlev, and G. Morfill, *Contrib. Plasma Phys.* **56**, 253 (2016).
2. V. E. Fortov and G. E. Morfill, *Complex and Dusty Plasmas: From Laboratory to Space*. (CRC Press, 2010).
3. A. M. Lipaev, S. A. Khrapak, V. I. Molotkov, G. E. Morfill et al., *Phys. Rev. Lett.* **98**, 265006 (2007).
4. V. N. Tsytovich, G. E. Morfill, U. Konopka, and H. Thomas, *New Journal of Phys.* **5**, 1 (2003).
5. V. N. Tsytovich, S. V. Vladimirov, and G. E. Morfill, *Phys. Rev. E* **70**, 066408 (2004).
6. V. N. Tsytovich, S. V. Vladimirov, and G. E. Morfill, *JETP* **102**, 334 (2006).
7. V. N. Tsytovich, S. V. Vladimirov, G. E. Morfill, and J. Goree, *Phys. Rev. E* **63**, 056609 (2001).
8. D. S. sonov et al., *Phys. Rev. E* **67**, 036404 (2003).
9. V. V. Balabanov, L. M. Vasilyak, S. P. Vetchinin, A. P. Nefedov, D. N. Polyakov, and V. E. Fortov, *Journal of Experimental and Theoretical Physics* **92**, 86 (2001).
10. V. V. Shumova, D. N. Polyakov, L. M. Vasilyak, *Plasma Phys Rep+* **45**, 285 (2019).
11. V. V. Shumova, D. N. Polyakov, and L. M. Vasilyak, *Plasma Sources Sci T* **26**, 035011 (2017).
12. . A. Artsimovich and R. Z. Sagdeev, *Plasma Physics for Physicist*. (Atomizdat Publisher, Moscow, 1979).
13. G. G. dinos, A. V. Ivlev, and J. P. Boeuf, *New J. Phys.* **5**, 32 (2003).
14. J. P. Boeuf and L. C. Pitchford, *Phys. Rev. E* **51**, 1376 (1995).
15. D. Kaganovitch and L. D. Tsendl, *IEEE Trans. Plasma Sci.* **20** (2), 62 (1992).
16. . D. Tsendl, *Plasma Sources Science and Technology* **4** (2), 200 (1995).
17. V. A. Kolobov and V. A. Godyak, *IEEE Trans. Plasma Sci.* **23**, 503 (1995).
18. V. A. Smirnov and K. E. Orlov, *JETP Letters* **23**, 39 (1997).
19. Yu. P. Raizer, M. N. Shneider, and N. A. Yatsenko, *Radio-Frequency Capacitive Discharges*. (CRC Press, 2019).
20. *Encyclopedia of Low-Temperature Plasma* (edited by V. E. Fortov). Introductory Volume II. P. 63 (Nauka, Moscow, 2000) [in Russian].
21. V. A. Godyak, R. B. Piejak, and B. M. Alexandrovich, *IEEE Trans. Plasma Sci.* **19**, 660 (1991).
22. V. A. Tsytovich, *Physics-Uspekhi* **40**, 53 (1997).
23. M. Kretschmer, S. A. Khrapak, S. K. Zhdanov, H. M. Thomas, G. E. Morfill et al., *Phys. Rev. E* **71**, 056401 (2005).