

**DEVELOPMENT OF A CATHODE RESISTANT TO VACUUM CHAMBER OPERATION CONDITIONS**

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The aim of this work is to develop a thermoemission cathode that would ensure the required operating parameters and remain operable after long, several-day, exposure to the air without any additional amputation. Cathode thermoemitter degradation ("poisoning") processes are overviewed. The problem of degradation of tungsten-barium cathodes is caused by the penetration of chemically active substances (for example, oxygen) into the interior space of a cathode. The "poisoning" process is so complex that it can hardly be simulated by simple theoretical methods. Because of this, the cathode "poisoning" degree under exposure to the atmosphere is usually assessed using experimental data.

The analysis of publications on the resistance of cathode emitters to atmospheric exposure showed that one of the most promising solutions to the cathode "poisoning" problem is the use of an emitter based on barium scandate. A cathode construction diagram was chosen, and a laboratory prototype cathode was made. The current dependence of the discharge voltage at different xenon flow rates and the xenon flow rate dependence of the discharge voltage at different currents were studied experimentally (xenon was the plasma-forming gas). During the tests, the cathode was periodically removed from the vacuum chamber to inspect it for further use, the maximum duration of continuous exposure to the air was 14 days, and the resets did not reveal any significant change in the performance.

The use of barium scandate as an emission-active substance for the thermoemission cathode improved its resistance to atmospheric exposure. The practical use of the cathode developed in experimental studies, for example, in the vacuum chamber of the plasmaelectrodynamics setup of the Institute of Technical Mechanics of the National Academy of Sciences of Ukraine and the State Space Agency of Ukraine, will eliminate frequent cathode replacements, thus significantly speeding up research activities.

**Keywords:** *thermoemission cathode, emitter, plasma source, barium scandate.*

1. Govoryakin R. G., Shepel' V. V. Course in General Physics. Moscow: Vysshaya Shkola, 1972. 230 pp. (in Russian).
2. Polivnikova O. V., Zemchikhin E. M. Helical cathodes for microwave heating magnetrons. *El-ektrotekhnika*. Ser. 1. 1996. No. 1. Pp. 40-45. (in Russian).
3. Kudintseva G. A., Mel'nikov A. I., Morozov A. V. et al. Thermoemission Cathodes. Moscow - Leningrad: Energiya, 1966. 368 pp. (in Russian).
4. Lazarev V. B., Sobolev V. V., Shaplygin I. S. Chemical and Physical Properties of Simple Metal Oxides. Moscow: Nauka, 1983. 240 pp. (in Russian).
5. Plankovsky S. I., Ostrovsky E. K., Tsegelnik E. V. Barium scandate based impregnated cathode. *Aero-space Engineering and Technology*. 2008. No. 2. Pp. 78-84. (in Russian).
6. Mozhes B. Ya. Physical Processes in an Oxide Cathode. Moscow: Nauka, 1968. 479 pp. (in Russian).

7. Kiselev A. B. Metal Oxide Cathodes of Electron Devices. Moscow: MFTI, 2001. 240 pp. (in Russian).

8. Yudinskaya I. V., Paromova M. V. Synthesis and study of the thermal stability and emissive ability of barium scandates. Izvestiya AN SSSR. Neorganicheskiye Materialy. 1975. V. 11. No. 10. Pp. 1805-1808. (in Russian).

9. Shnyukov V. F., Lushkin A. E., Get'man O. I. et al. Effect of scandium on the properties of dispenser cathodes. Bulletin of the Russian Academy of Sciences: Physics. 1994. V. 58. No. 10. Pp. 171-175. (in Russian).

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