DOI: 10.34854/ICPAF.52.2025.1.1.194

SYSTEM FOR MEASURING ION BEAM EMITTANCE *)

Brul A.V., Kuzmin E.I., Kurkuchekov V.V., Sklyarov V.F., Starostenko A.A.

Budker Institute of Nuclear Physics SB RAS, Novosibirsk, Russia, press@inp.nsk.su

The task of ion implantation in various materials holds great practical significance, driving the advancement of modern technologies and maintaining its relevance. With increasing demand for microelectronics and semiconductor components in industries such as computing, telecommunications, automotive, and electronics, the requirements for implantation technology are growing, both for the ion source characteristics and for precise measurement methods.

To address these needs, the Budker Institute of Nuclear Physics (BINP) has developed an ion source based on a Penning discharge for implantation technologies, with a beam energy up to 80 keV, capable of operating with noble gases (Ne, Ar, Kr). Beam emittance control is essential to ensure high precision and uniformity in implantation. Low emittance reduces implantation non-uniformities related to channeling and multiple scattering effects and increases ion concentration in the target area, enhancing implantation quality and reducing defects in the crystal lattice. Optimizing implantation parameters, including the energy profile and penetration depth, allows for meeting the specific demands of various semiconductor technologies.

A “pepper-pot” diagnostic method was used to measure beam emittance, which involves analyzing individual beamlets filtered through a mask with an array of slits of specific shape and size. The distribution of beamlets was recorded by imaging the illuminated profile on a fluorescent ceramic with a fast camera. Since the beam profile in the experiment is ribbon-shaped, a “pepper-pot” mask with longitudinal and transverse slits was used. Thus, a diagnostic system for measuring the emittance of a beam up to 80 keV was developed and fabricated. Detailed analysis of the geometric characteristics and technical specifications of the diagnostic setup is provided. Initial experiments were conducted, and the first emittance data were obtained and analyzed.

References

[1]. Kremers H.R., Beijers J.P.M., & Brandenburg, S. / “A pepper-pot emittance meter for low-energy heavy-ion beams” // Rev. of Sci. Inst. (2013), Vol. 84.

[2]. Dolinska M.E., & Doroshko N.L. “PEPPER-POT DIAGNOSTIC METHOD TO DEFINE EMITTANCE AND TWISS PARAMETERS ON LOW ENERGIES ACCELERATORS.” Problems of Atomic Sci. and Technol., 2002, № 2, Series: Nuclear Physics Investigations (40), p. 107-111.

[3]. Kobayashi H., Yamazaki Y., Kurihara T., Sato I., Asami A., Otani S., & Ishizawa Y. “Emittance Measurement for High-Brightness Electron Guns.” Proc. of the 1992 Linear Accelerator Conf.

*) abstracts of this report in Russian