Characteristics of ions produced from plasma focus devices and application to material studies

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Energetic ion beams of high fluence are produced for a few hundreds of ns durations in a plasma focus device along with other radiations like X-rays, electrons and neutrons [1]. Such ions carry information about the physical processes and dynamics of plasma focus device and have been utilized in many applications such as material irradiation and ion implantation. Hence study of their emission characteristics is important for basic understanding of the device as well as technological applications. The emission characteristics i.e. fluence, peak density, energy and angular distribution of ions strongly depend on the device parameters viz. electrodes shape & dimension, filling gas pressure and operation energies.

In the present work, effects of deuterium gas filling pressure and operation energy on ion emission characteristics have been studied in "MEPF-12" device using Faraday cup. Effects of electrode dimensions have also been studied using three different plasma focus devices operated at 2kJ, 11.5kJ and 17kJ energies respectively. The peak density and most probable energy of ions are observed to be varying with device parameters whereas ion fluence is found to be nearly independent of them. The angular emission characteristics of ions are measured using CR39 film and it is observed that ion emission is anisotropic with more ions in forward direction. The anisotropy factor is seen to vary with variation in filling gas pressures.

Ions from such PF devices have been used for irradiation of fusion reactor relevant materials and nanoparticles formation on different substrates under multiple focus discharges. Materials having different physical and thermal properties have been irradiated for comparative analysis as well as to understand the mechanism of plasma-material interaction [2]. Carbon nanoparticles have also been produced and deposited on different substrates like Si, Ti, Mo and W and characterized using various techniques (SEM, XRD, EDX, Vicker's Hardness). Details of the experiments and comparative analysis of observed characteristics along with reported results shall be presented.

References

[1] J. W. Mather, Phys. Fluids 8, 366 (1965)
[2] Ram Niranjan *et al.*, Appl. Surf. Sci. 355, 989 (2015)