DIAGNOSTICS OF SUBMICRON MULTI-ELEMENT FOCUSED ION BEAMS FROM AN INTENSE MICROWAVE PLASMA*

Jose V. Mathew and Sudeep Bhattacharjee
Department of Physics, Indian Institute of Technology - Kanpur, India – 208016

Focused ion beams (FIB) are highly important for applications in nanotechnology. Conventional Liquid Metal Ion Source (LMIS) based FIB systems provide primarily Gallium ions with undesirable contamination effects[1]. Plasma based FIB systems can provide a variety of ions that can be selectively utilized according to applications such as structuring, implantation, irradiation studies etc. The beam currents at the substrate are found to be several orders of magnitude ($>10^3$) larger than LMIS for a given solid angle of acceptance[2]. Important performance parameters for FIB are the beam spot size which determines the precision of the job to be performed, the image side brightness which decides the efficiency of operation and the ion energy spread which contributes to chromatic aberration in beam optics.

A multi element focused ion beam (ME-FIB) system is developed using a microwave driven multicusp plasma ion source[3]. High density plasmas ($\sim 2 \times 10^{11}$ cm^{-3}) are generated in a compact volume with a small ion energy spread (~ 5 eV for Argon) at the plasma meniscus, which is comparable to that of LMIS[4]. With a 1 mm plasma electrode aperture, ~ 100 nA of Ar ion beam current at 18 keV, focused to < 30 micron spot on Cu substrate have been obtained, using purely electrostatic focusing. The spot size will be further improved using higher focusing potentials, smaller electrode apertures and by incorporating magneto static multipolar fields.

The beam spatial profile will be estimated from (a) current distribution measured by scanning a fine micron size wire across the beam and recording the transmitted current on a Faraday cup and, (b) using fluorescence imaging of the focused beam with optical photo sensitive diodes. To demonstrate the potential of ME-FIB system, ions such as, H^+, Ar^+, Kr^+ etc., will be irradiated on ~ 100 nm thin films of metallic and insulating materials under different operating conditions and time resolved measurements of transmitted beam current will be performed.

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* Work supported by Department of Science and Technology and Nanoscale Science and Technology Initiative, Government of India