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3D MAPPING OF ION VELOCITIES IN AN ECR PLASMA REACTOR BY LIF, DOPPLER SHIFT MEASUREMENTS

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Electron cyclotron resonance (ECR) is one of several plasma generation techniques that are being developed to overcome the Ultra Large Scale Integration (ULSI) constraints (0.25 μm) in plasma processing of micro-electronic and photonic materials. To fully exploit the control offered by independent plasma generation in ECR reactors, it is necessary to understand how ions are formed and how they gain energy, and to know their velocity $\vec{v}$ at the wafer surface. Up to now, ion velocity distribution function (ivdf) measurements have been performed with Langmuir probes or by pinhole sampling electrostatic energy analysers. These methods are intrusive and are limited in angular resolution.

In this work, we have used non-intrusive laser induced fluorescence (LIF) for extensive measurements of metastable argon ion, $\text{Ar}^+(3p^4 3d^2 G_{9/2})$, velocity distributions both in an ECR source and in the reactor downstream from this source. Using a tunable, cw dye laser, three ivdfs : v_z , v_r and v_θ , are deduced from the Doppler shift in the LIF excitation spectrum and their variations as a function of magnetic field amplitude, microwave power, gas pressure and mixture, and R.F. bias voltage of the wafer have been studied.

Downstream, close to the wafer, we observe a bimodal ion velocity distribution : the fast component, created inside the source, follows magnetic flux lines into the reactor ; the slow component, created mostly where the plasma expands from the source into the reactor chamber, is more isotropic. The relative amplitudes of these two components, the average ion energy, and the ion energy distribution can be controlled by changing pressure and magnetic field.

⁽¹⁾ Associated with C.N.R.S. (UA 008)