PS-003

Diagnostics of Magnetron Sputtering Plasmas: Distributions of Density and Velocity of Sputtered Metal Atoms

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Deposition of thin films using magnetron sputtering plasmas is a well-developed, classical technology. However, detailed investigations using advanced diagnostics are insufficient in magnetron sputtering, in comparison with plasma-aided dry etching and plasma-enhanced chemical vapor deposition. In this talk, we will show examples of diagnostic works on magnetron sputtering employing metal targets. Diagnostic methods which have fine spatial resolutions are suitable for magnetron sputtering plasmas since they have significant spatial distributions. We are using two-dimensional laser-induced fluorescence spectroscopy, in which the plasma space is illuminated by a tunable laser beam with a planer shape. A charge-coupled device camera with a gated image intensifier is used for taking the picture of the image of laser-induced fluorescence formed on the planer laser beam. The picture of laser-induced fluorescence directly represents the two-dimensional distribution of the atom density probed by the tunable laser beam, when an intense laser with a relatively wide linewidth is used. When a weak laser beam with a relatively narrow linewidth is used, the laser-induced fluorescence represents the density distribution of atoms which feel the laser wavelength to be resonant via the Doppler shift corresponding to their velocities. In this case, we can obtain the velocity distribution function of atoms by scanning the wavelength of the laser beam around the line center.

Keywords: plasma diagnostics, sputtering

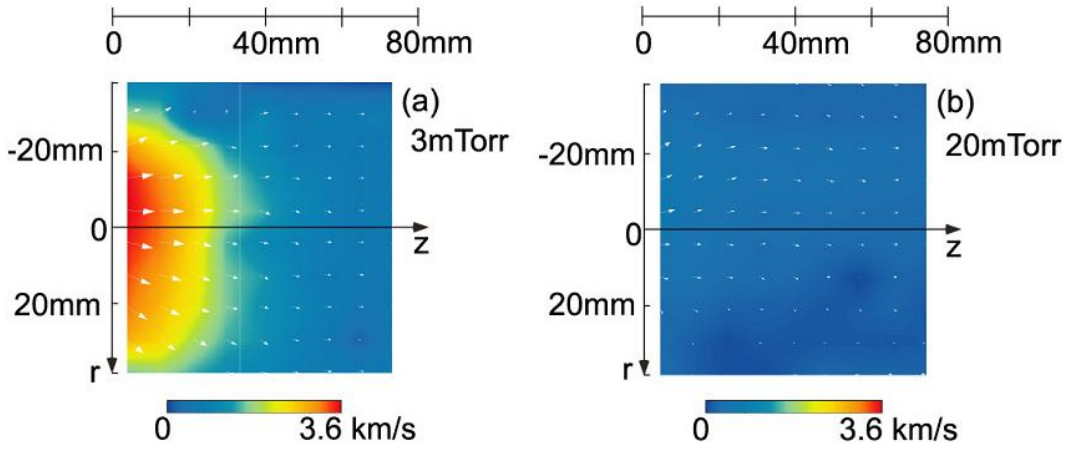

Fig. 1. Shows the spatial distributions of the average velocities of iron atoms ejected by magnetron sputtering of an iron target. The average velocity was obtained by calculating the first-order moment of the velocity distribution function at each pixel of the ICCD camera. The comparison between the distributions of the average velocities at 3 and 20 mTorr indicates significant relaxation of the energy of sputtered particles in ambient argon gas with a higher pressure. This diagnostic result would be useful for choosing the gas pressure and the distance between the target and the substrate when damageless deposition is required by magnetron sputtering.