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A gridded planar probe as a plasma diagnostic tool in a dc magnetron sputtering

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A gridded planar probe has been developed to measure plasma parameters in a dc magnetron sputtering discharge. The gridded probe essentially consists of an outer grid in conjunction with the inner collector forming a stacked electrode configuration. The grid space needs to be less than the Debye length in order to assume the planar plasma-sheath structure. In addition, the grid-to-collector distance should be shorter than the mean free path of electron ionization collisions to prevent undesirable plasma generated inside the probe. The I-V characteristic of the probe is obtained by applying bias voltages to both electrodes but only measuring the current from the collector. Consequently, plasma parameters including ion flux, electron temperature, and ion and electron densities can be calculated from the probe characteristic based on the collisionless planar sheath model. It is found in the ion saturation region that the probe current is almost independent of the bias voltage due to a well-defined planar sheath structure adjacent to the grid. As a result, the ion flux can be obtained to a fair degree of certainty. For the discharge conditions achieved in this study, electron density and temperature are found in the range of ~10^{15} m^{-3} and 2-6 eV, respectively, which agree well with those obtained using a cylindrical Langmuir probe and a flat probe with a guard ring.

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