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An approximate method for analysis of double probe characteristic in the absence of ion saturation LEONID DORF, SHAHID RAUF, KEN COLLINS, Applied Materials — Ion current to a double probe (DP) with cylindrical leads is subject to sheath expansion effects, so probe's volt-ampere characteristic (VAC) differs significantly from a simple *tanh*-like shape, which is valid only in the limit of an infinitely large ratio of probe radius, r_p, to Debye length, λ_D: $\xi_p = r_p/\lambda_D$. Thus, a commonly employed simple method, in which straight lines are fitted to VAC at zero and large positive (or negative) bias voltages, and the ordinate of the intersection point is used as $I_{sat} = 2\pi\ r_p L_p e^{-1/2} N_{is} \sqrt{T_e/M_i^+}$, often results in overestimation of the calculated ion density, N_{is}, by a factor $\eta_i^{-1} = N_{is}\ /\ N_i^+ \sim 2$ – 3, where N_i^+ is the true positive ion density. The shape of the VAC and therefore value of η_i are also strongly affected by plasma's electronegativity, $\beta = N_{neg}\ /\ N_e$. In this work, for the first time, we present an approximate analytical expression for $\eta_i$as a function of β and $\xi_{ps} = r_p\ /\ \lambda_D\ (N_{is})$, which is valid in the wide range of parameters: $\beta = 0$ – 40, and $\xi_{pi} = r_p\ /\ \lambda_D\ (N_i^+) = 0.1$ – 10. We obtained this expression in O_2 and CF_4, for $T_e/T_{neg} = 30$, by solving "radial motion" equation in the presence of singly-charged electronegative ions [H. Amemiya et al., Plasma Sources Sci. Technol. **8**, 179 (1999)], and numerically calculating a family of DP VAC. We also obtained a formula for η_i (M_i^+, ξ_{ps}) in electropositive plasma for ξ_{pi} = 0.1 – 50 and a wide range of ions, from H to Xe.

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