Control of the particle flux and energy at the substrate in an inverted cylindrical magnetron reactor for plasma PVD

A. Todoran[1,2], M. Mantel[2,3], A. Bés[1], C.Vachey[2] and A. Lacoste[1]
[1]*Laboratoire de Physique Subatomique et de Cosmologie, Université Grenoble-Alpes, CNRS/IN2P3, 53, rue des Martyrs, 38026 Grenoble Cedex, France*
[2]*Ugitech S.A., Avenue Paul Girod, 73403 Ugine Cedex, France*
[3]*SIMAP, Grenoble INP, 38402 St Martin d'Hères Cedex, France*

Inverted cylindrical magnetrons (ICM) or hollow cathodes are often used in DC, pulsed DC or mid-frequency AC mode for coating complex objects with thin films deposited by means of plasma PVD. Since in such a configuration the substrate is inherently surrounded by the target and, hence by the plasma, the energy flux of the impinging particles represents the main contribution to the substrate heating [1]. This can readily constitute a limiting factor for the deposition process, especially in the absence of its cooling.

This work concerns a DC driven ICM configuration subjected to several constraints: not only is the substrate surface area small (e.g. wire) by comparison to the cathode surface area, but its imposed potential is the ground one, thus, itself constituting the anode surface of the considered setup. The most important heating factors are highlighted and, based on the technique employed for a floating substrate configuration [2], a mean to raise the plasma potential by positively polarizing with respect to the ground an additional electrode is proposed. This additional surface generates a redistribution of the current and, consequently, regulates the electron flux on the substrate. The obtained results are shown as a function of bias applied on the additional electrode and discussed in terms of impact on the substrate heating. The electrical characteristics of the discharge (plasma and floating potential, electronic temperature) obtained by simple measurements are equally given.

[1] H. Kersten, H. Deutsch, H. Steffen, G.M.W. Kroesen, R. Hippler, *Vacuum:* **63**, 385 (2001)
[2] J.R. Doyle, A. Nuruddin, J.R. Abelson, *Journal of Vacuum Science and Technology A:* **12**, 886 (1994)