PO3048

Direct measurements of the ion flux at the substrate in reactive HiPIMS

Martin Cada[1], Daniel Lundin[2], Zdenek Hubicka[1]

[1]Institute of Physics of the AS CR, Prague 8, Czech Republic [2]CNRS — Université Paris-Sud, Orsay, France

cada@fzu.cz

A direct measurement of the ion flux impinging on the substrate during ionized physical vapour deposition is valuable input when optimizing thin film deposition processes such as High-Power Impulse magnetron sputtering. However, these measurements are often complicated by the fact that they require expensive diagnostic equipment. For that reason an innovative approach consisting of an extension of a quartz crystal microbalance (QCM) sensor has been investigated in the present contribution. On top of deposition rate, the modified QCM is able to measure ionized fraction of depositing particles and ion flux on the substrate. Recently reported results proved that magnets placed at the top of the QCM sensor are able to significantly reduce electron current on the positively biased electrode attached to the crystal and in this way measure only the deposition rate of neutral particles. On the other hand, by applying a sinusoidal voltage at a frequency of 300 kHz at the probe electrode instead of constant positive bias then one can determine the time-resolved ion flux on the substrate by means of the so called Sobolewski method. Furthermore, a detailed analysis of the oscillating current and voltage waveforms at the electrode can also provide information on the impedance of the space charge sheath around the electrode. Here it will be shown that the probe results are particularly useful in reactive HiPIMS discharges, where the temporal evolution of the ion flux and the space charge sheath impedance gradually changed when the discharge passed from metallic mode into compound mode. We therefore propose to use the simple multi-purpose ion probe for reactive process control to achieve for example stable operation in the transition regime.
The work has been supported by the GACR through project 15-00863S, the French National Center for Scientific Research (CNRS) and the European Commission under the 7th Framework Programme through the ‘Factories of the Future’ program, FP7-2013-NMP-FoF grant number 608800.

Keywords
HiPIMS
impedance
ion flux
reactive sputtering