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HiPIMS deposition of TiOx in an industrial-scale apparatus: effects of target size and deposition geometry on hysteresis

Alessandro Patelli[1], Marino Colasuonno[1], Martino Tosello[1], Diego Giordani[1], Giovanni Mattei[2], Montri Aiempanakit[3], Tomas Kubart[3], Alessandro Surpi[1]

[1]Veneto Nanotech, Marghera Venezia, Italy [2]Università di Padova, Padova, Italy [3]The Ångström Laboratory, Uppsala University, Uppsala, Sweden

patelli@civen.org

High power impulse magnetron sputtering (HiPIMS) has attracted a widespread interest in the scientific community because of substantial improvements over conventional magnetron sputtering in the quality of deposited coatings and in the coating-substrate adhesion. More recently, a number of reports appeared showing that the hysteresis effect may be also significantly reduced in the HiPIMS mode resulting in an increase of the deposition rate of stochiometric compounds. Yet, presently is not clear how much of these results can be translated into large industrial-scale apparatus. Also, the peak power or pulsing frequency of HiPIMS was reported to have a significant impact on the deposition rate.
In this work an industrial coating system has been used to study HiPIMS deposition of TiO_2. The experiments have been performed using 1 cubic meter deposition chamber (produced by ThinFilms) with 12” × 4.9” large titanium target powered by Hüttinger Truplasma HiPulse 4002® power supply. Oxygen is introduced as reactive gas by a flow-meter.
A set of hysteresis curves, taken at various pulse repetition frequencies (200 Hz, 500 Hz), is presented and compared with conventional DC MS from the same apparatus. The hysteresis is recorded using the emission lines of Ti (509.29 nm) and O (777.19 nm), target voltage and current and by the total pressure measured by a capacitance manometer. The results are also compared to previous experiments carried out using a laboratory scale system. Based on these comparisons the role of the geometry and size of the deposition chamber and the size of the target are assessed. Finally, the deposited films have been characterized by a number of different analytical techniques like scanning electron microscope (SEM), ellipsometry, XRD and Raman spectroscopy. The results show that depending on the frequency of HiPIMS operation, the deposition rate of rutile TiO_2 can be substantially increased.

Keywords
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HiPIMS
reactive magnetron sputtering