

## On the deposition rate during High-Power Impulse Magnetron Sputtering.

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For several years, the High-Power Impulse Magnetron Sputtering (HiPIMS) technology has attracted much attention as it enables the synthesis of functional thin films with enhanced or new properties <sup>1</sup>. During the high-power plasma pulse, typically characterized by peak current densities of the order of sev. A/cm<sup>2</sup> and a target voltage in the kV range, the sputtered film forming species are ionized and the film growth process is assisted by a flux of ions whose trajectory and energy can be controlled by an appropriate biasing of the substrate. The major drawback of this technology is the decrease of the deposition rate as compared to the rates achieved during DC magnetron sputtering discharge, in the same working conditions.

One reason for the reduced deposition rate is the propensity of the HiPIMS discharge to transit from the argon-driven sputter regime towards the self-sputtering mode, where metal ions are used to sputter the target. The later situation is detrimental to the deposition rate as some of the film-forming species do not reach the substrate and the erosion rate of the target is reduced. In this contribution, where short (< 50 $\mu$ s) high-power pulses are used (see e.g. Fig 1), we first analyze the influence of the exchange of momentum occurring between the sputtered atoms (Cu, Ti or W) and the argon background gas, i.e. the sputtering wind <sup>2</sup>, on this transition and consequently on the decrease of deposition rate.

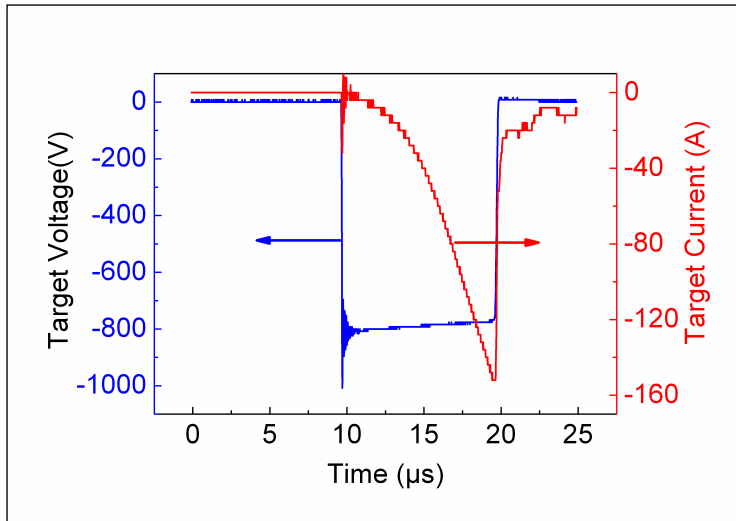


Fig 1: Typically current - voltage waveform during a short high-power plasma pulse.

Secondly, we show it is possible to increase the deposition rate, above the DCMS threshold, in the case of a reactive Ar/O<sub>2</sub> process used for the growth of tungsten oxide thin films provided that the HiPIMS deposition experiment is performed at high oxygen content (> 80 %) <sup>3</sup>. This situation is represented in Fig 2.

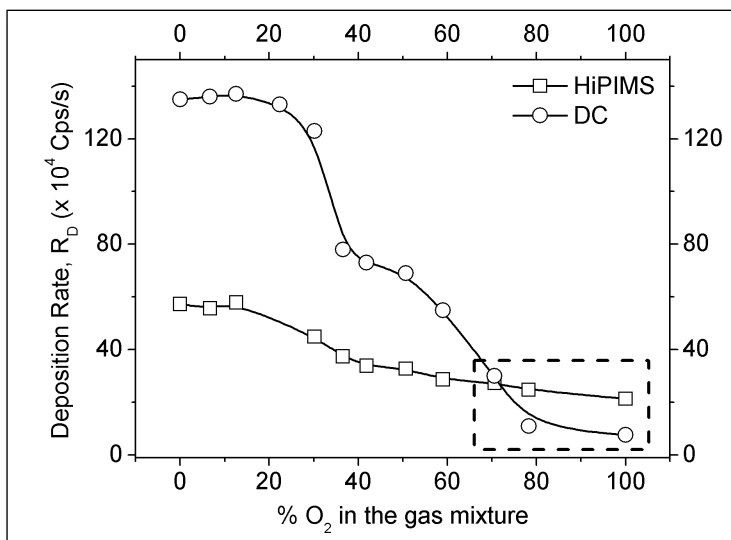


Fig. 1: Deposition rates obtained from X-Ray Fluorescence measurements for the DC and HiPIMS reactive discharges as a function of the oxygen content in the gas mixture (from <sup>3</sup>).

#### References :

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<sup>2</sup> D.W. Hoffman, J. Vac. Sci. Technol. A **3**, 561 (1985).

<sup>3</sup> A. Hemberg, J.-P. Dauchot, R. Snyders, and S. Konstantinidis, J. Vac. Sci. Technol. A **30**, 040604 (2012).