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A simple approach to transpose the deposition conditions in two different magnetron sputtering chambers: a case study of oxidation of sputter-deposited VN films

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Abstract content

Magnetron sputtering is a vacuum coating technique that enables the deposition of any metal, alloys or ceramic compounds onto a wide range of substrate materials. It is characterized by high purity films, high deposition rates, outstanding uniformity on large-area substrates, the possibility of excellent coverage of small features, and remarkably high adhesion of films. These peculiarities render this technique suitable for various applications, such as hard and wear-resistant coatings, decorative coatings, electronic thin films… [1]. Large-scale sputtering chambers are used to make possible these industrial applications. They differ from standard laboratory sputtering reactors in numerous attributes like volume, cathode dimension, pumping speed, substrate cleaning process, among others. Thereby, it is essential to establish a criterion to transpose the results from the lab standard machines to the industrial ones.

This work presents a simple approach to compare the deposition parameters between two different sputtering reactors: a semi-industrial and a laboratory-scale one. In our model, strong assumptions have been made. The difference in volume between the deposition chambers, the different pumping speeds in each machine, and the magnetron size have not been considered. We assume that the fundamental parameter that governs the growth of thin films is the energy at which the sputtered atoms arrive on the substrate surface. Hence, the criterion to have analogous films from both machines is that the sputtered atoms coming from the target arrive with the same energy at the substrate. A comparison of VN depositions and afterward oxidation of the as-deposited films is carried out to test the criterion. We fixed the deposition conditions of the semi-industrial machine. On the other hand, we conduct three sets of VN depositions with different working pressure at the same target-substrate distance in the laboratory-scale machine. The VN films of series II are deposited with the equivalent conditions of the semi-industrial chamber, series I and III with lower and higher working pressure, respectively. All films are post-oxidized in a furnace under atmospheric pressure at 550°C for up to 3.5 minutes. XRD and infrared camera show that the oxidized films from the semi-industrial chamber transform into thermochromic VO_2. For the samples from the laboratory-scale machine, only the oxidized films deposited with the analogous conditions (series II) display VO_2 with thermochromic performance. Our criterion evidence that it is possible to transpose depositions from one sputtering chamber to another (even to an industrial scale).

References

[1] Kelly *et al.*, Vacuum. **56** (2000) 159–172.