Sputtering process of Aluminum in Ar/He mixtures

S. Ibrahim[1], A. Caillard, P. Brault, T. Lecas, A.L. Thomann

[1] *Laboratoire GREMI, UMR 7344, CNRS-université d'Orléans, 14 rue d'Issoudun, BP 6744, 45067 orléans cedex 2*

mél: sara.ibrahim@univ-orleans.fr

In the frame of fusion research, the interaction of helium with various materials has been widely studied. For instance, it has been proved that He implantation in tungsten at high substrate temperature and low ion kinetic energy leads to the formation of fiberform nanostructures, called "fuzz" [1]. It has been observed that this nanostructure is formed at a kinetic energy below the atomic displacement threshold, and exhibits high porosity (90 %), which could be of great interest for various applications (light absorption, catalysis etc.). Further investigations have evidenced the formation of various porous structures on molybdenum, nickel, iron or aluminum surfaces [2]. The underlying formation mechanism seems to be related to the very particular behavior of He inside metal lattices [3]. To take advantage of He insertion and release at metal surfaces, several authors have investigated the deposition of metal thin films by magnetron sputtering in helium gas. Various results have been obtained like formation of He filled bubbles in the film thickness and/or apparition of porosity [4,5].

In the present work, we studied Al target sputtering in various He/Ar mixtures in the aim to synthesize nanostructured films for hydrogen production application. The evolution of the magnetron discharge depending on the He percentage in the gas phase was characterized by following the cathode voltage at a fixed current. By comparing with the deposition rate evolution, three sputtering regimes have been evidenced leading to very different depositions conditions at the substrate and thus, to different film morphologies. The nature and energy distribution function of sputtered and backscattered atoms from the target were analysed by performing SRIM simulations. The ion energy distribution function of Al^+, Ar^+ and He^+ ions was determined using mass spectrometry. Good correlations have been obtained between calculations and experiments for sputtered Al atoms. Nevertheless, unexpected Ar^+ and He^+ distribution functions were found at high He % and/or low gas pressure inside the chamber. Moreover, SRIM simulations predict that high energy He^+ (60 eV) are backscattered at the target, reaching the substrate. Since they are neutralized at the target, they were not detected, although their role on film growth seems tremendous. Therefore, this poster will give us the opportunity to discuss both problems.

Références

[1] M. Tokitani, S. Kajita, S. Masuzaki, Y. Hirahata, N. Ohno, T. Tanabe, Exfoliation of the tungsten fibreform nanostructure by unipolar arcing in the LHD divertor plasma, Nucl. Fusion **51** (2011) 102001

[2] S. Kajita, T. Yoshida, D. Kitaoka, R. Etoh, M. Yajima, N. Ohno, H. Yoshida, N. Yoshida, Y. Terao, Helium plasma implantation on metals: Nanostructure formation and visible-light photocatalytic response, J. Appl. Phys. **113** (2013) 134301

[3] L. Pentecoste , A-. Thomann, P. Brault, T. Lecas, P. Desgardin, T. Sauvage, M.-F. Barthe, Substrate temperature and ion kinetic energy effects on first steps of Heþ implantation in tungsten: Experiments and simulations, Acta Materialia **141** (2017) 47-58

[4] L. Shi, C. Liu, S. Xu, Z.Y. Zhou, Helium-charged titanium films deposited by direct current magnetron sputtering, Thin Solid Films. **479** (2005) 52–58

[5] V. Godinho, P. Moskovkin, R. Álvarez, J. Caballero-Hernández, R. Schierholz, B. Bera, J. Demarche, A. Palmero, A. Fernández, S. Lucas, On the formation of the porous structure in nanostructured a-Si coatings deposited by dc magnetron sputtering at oblique angles, Nanotechnology. **25** (2014) 355705

Statut :