Surface analysis of Gradient Stainless Steel Buffer Layer to Support Aluminium Nitride Diffusion Barrier for Carbon Nanotubes Growth

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Abstract

To obtain carbon nanotubes (CNTs) by chemical vapor deposition on conductive substrates, such as cooper or stainless-steel, diffusion barriers (DB) are generally used to avoid catalyst diffusion. Two properties of the DB must be thermal stability and expansion coefficient similar to the substrate. Our research is focused on testing a new multilayer with suitable characteristics having an efficient DB functionality. Using DC-pulsed sputtering process we can deposit different combinations of layers on stainless-steel 304 (SS304). In previous works, we used Ti and Ni between SS304 and DB (Al_2O_3 or AlN) to act like a buffer layer, but it requires the exchange of sputtering targets during the deposition process. The multilayer system used in the present work simplify the process by using a target of SS304. The obtained layer was nitrided more and more during deposition. This allows finally to obtain a gradient layer of nitrided steel that acts as a buffer layer for the diffusion barrier of aluminium nitride (AlN). We tested a gradient layer formed by three layers. Each layer is deposited using the same pressure (1 Pa), power (50 W) and frequency (100 kHz, duty-cycle 2016 ns). But the N_2/Ar flow ratio was changed during the deposition process. The initial flow ratio was 0/20 sccm, then was increased to 3/17 sccm and finally was 7/13 sccm. For this study, the three layers were deposited independently on three polished glass substrates during 600 s. X-ray photoelectron spectroscopy (XPS) analysis provided us the chemical composition of each layer forming the gradient stainless steel buffer layer. Rich phases of nitrogen were obtained when the N_2/Ar flow ratio was increased. As expected, gradual nitriding of the stainless steel was shown. Additionally, the distribution of the nitrogen bound to the different elements present in the steel was evidenced. Finally, it was observed that when the N_2/Ar flow ratio increases, the deposition rate of the stainless-steel layers decreases.

References

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Figures

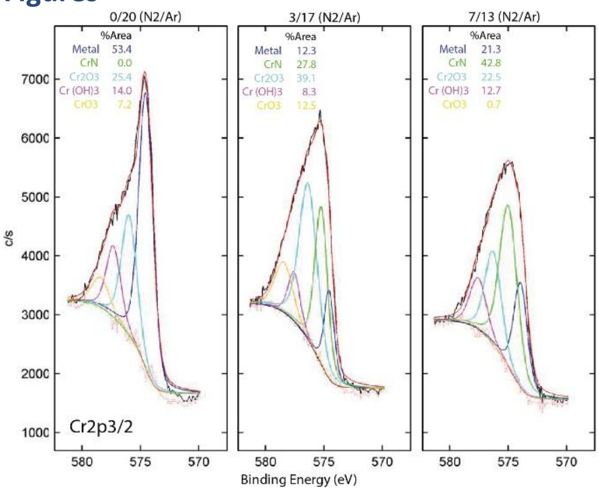

Figure 1. Sample of XPS spectrum Cr_2p3/2 detected for the stainless-steel layers deposited on glass under different N_2/Ar flow ratio conditions.