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Impurity suppression in sputtered metallic thin films using HiPIMS

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Composition and microstructure of thin films deposited by PVD are often influenced by the presence of residual gas. Therefore, it would be desirable to enable thin film growth without residuals incorporation. Strategies to avoid impurities incorporation are substrate heating, applying substrate bias, and reduction of base pressure to ultra-high vacuum (UHV) conditions. Industrial demand for low temperature and low cost precesses often precludes these approaches. More recently, a very important question has been raised regarding high power impulse magnetron sputtering (HiPIMS) to form pure metallic films at low deposition rates and high values of base pressure in the deposition chamber [1]. In this study, HiPIMS was applied for room temperature deposition of pure metallic thin films of Al, Ti and Cu. These metals are distinguished by their oxygen affinities and melting temperatures. Deposition of carbon top layers was used to differentiate between residual gas and post-deposition contamination. Elastic recoil detection analysis (ERDA) revealed that HiPIMS produces bulk-impurity-free metallic thin films. The growth of such high-purity metallic thin films can be partly explained by gas rarefraction and the self-cleaning effect of the bombarding ions. Moreover, densification effects presumably suppress post-deposition oxidation. Proposed deposition mechanism will be explained in sufficient detail. The compositional effects are correlated with differences in the film microstructure revealed by SEM, XRD and TEM analyses. [1] P.Pokorny et al., Plasma Processes Polym. 12, 416 (2015), Finacial support by the EU, grant No. 645725, project FRIENDS2, and the HGF via W3 program (S.G.) is gratefully acknowledged. This work was also funded by the ERDF, Project CAMBO, ITMS: 2622022079, and by Slovak grant agency VEGA, project no. 1/0503/15.

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