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Magnetron sputtering into deep grooves

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Magneton sputtering is a well-established technique to prepare various thin film coatings in wide range of industrial applications. However, deposition into the grooves, trenches or holes is complicated using this technique. Changes in process parameters can increase the penetration of the coatings into the grooves. Increase of pressure results in increase of scattering of sputtered atoms and higher number of sputtered atoms can enter the groove. However, they will soon hit the wall and do not penetrate deep enough. There are two reasons for this statement: 1. the atoms enter the groove at very broad angular distribution and 2. The atoms are scattered even inside the groove and their probability to hit the wall is high. On the other hand decrease of pressure and placing the sample far from the target can result in high mean free path, very well defined angular distribution of the sputtered atoms and deep coverage of the groove walls by the coating.
In this work influence of pressure and target-to-substrate distance in case of DC sputtering from Cr target is analyzed. Special fixtures were constructed in order to direct measuring of coating thickness on two Si substrates with distance between them 2, 4 and 6 mm up to 30 mm deep into the groove. Experiments were supported by Monte-Carlo simulation in SIMTRA, by discrete ordinates model developed in ANSYS Fluent and also by simple and advanced analytical model programed in C#. Very good correlation was found for all three approaches (models), allowing optimization of the process parameters in order to achieve the best coverage of the groove walls.
Recently the HiPIMS with positive pulse after the main HiPIMS pulse was reported as a method that increases the homogeneity of the coating inside 3D geometry. In this study comparison between the samples prepared by HiPIMS and HiPIMS with positive pulse after the main HiPIMS pulse (using two different power supplies) were performed and positive influence of HiPIMS with positive pulse on the homogeneity of the coating in the groove were confirmed.

Keywords
coating homogeneity simulations
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