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Mechanical properties of Ti2AlN thin film coatings before and after oxidation

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Ti_2AlN is a prominent member of the MAX phase materials, which are known to combine metallic and ceramic properties. Especially aluminum containing MAX phases are known to be oxidation resistant due to the formation of dense oxide scales which protect the underlying Ti_2AlN and the substrate from further oxidation [1]. The purpose of this study is to investigate the adhesion of the oxide scale and the influence of the oxidation process on the mechanical and tribological properties of MAX-phase coatings. Ferritic stainless steel samples were coated with Ti_2AlN using a multilayer physical vapor deposition of Ti and AlN layers and a subsequent annealing for 1h at 700°C [2]. After a characterization of the initial coatings microstructure, the samples were oxidized in a muffle furnace in ambient air for 5, 10, 20, and 100 h. The thermally grown oxides were identified as mainly α-Al_2O_3 with a minor fraction of TiO_2. The formation kinetics of the α-Al_2O_3 scales were investigated by XPS depth profiles. Similar to other MAX phase materials, a cubic oxide growth behavior was found. Further investigations on the mechanical properties of the oxidized samples were performed with scanning scratch tests, nanoindentation and tribological tests. In scratch tests, no spallation of the α-Al_2O_3 scales could be observed, which indicates a good adhesion to the underlying Ti_2AlN film. Nanoindentation experiments were performed to compare changes in hardness and elastic modulus of the oxidized film. Tribological tests at elevated temperatures were performed to investigate the coating's suitability for possible applications in aggressive Environments. [1] D. J. Tallman, B. Anasori, and M. W. Barsoum, Mat. Res. Lett. 1, 115–125 (2013); [2] L. Gröner, L. Kirste, S. Oeser, A. Fromm, M. Wirth, F. Meyer, F. Burmeister, and C. Eberl, Surf. and Coat. Techn., in press (2017)

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