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PVD-Synthesis and characterization of Mn+1AXn phase coatings

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In recent years, there were numerous publications on the synthesis and characterization on $M_{n+1}AX_n$ phases and also an increasing number of reports on their suitability for industrial applications, e.g. as protective coatings (J. Fu et al., J. of Nanomat., 1-12, 2015; Q. M. Wang et al., Corr. Sci. 53, 2948-2955, 2011). $M_{n+1}AX_n$ phases are a group of ternary nitrides or carbides with a hexagonal lattice structure, where M denotes an early transition metal, A is an element of group A and X is either nitrogen and/or carbon with n=1, 2, 3,… . Due to the mixture of strong covalent MX bonds and weaker ionic MA bonds, these materials exhibit a high corrosion resistance and good machinability as well as high ductility and good electrical and thermal conductivity.
In this poster, we report on the magnetron sputter deposition of multi-layered deposition of Ti and AlN/AlC coatings and a subsequent vacuum annealing step at 700°C for the synthesis of Ti_2AlN or Ti_2AlC respectively. Different substrates like sapphire, polycrystalline Al_2O_3 and ferritic stainless steels were coated and the substrate influence on adhesion, evolving thermal stresses, structure and phase composition was investigated.
The coatings' characterization was mainly carried out with Raman spectroscopy and compared with EDX- and XRD-measurements. Raman spectroscopy turned out to be a valuable alternative to other time consuming methods like XRD and EBSD to detect the different phases present in the coating. We present typical Raman spectra of thin films of Ti_2AlN and Ti_2AlC. Also the detection of oxide scales like α-Al_2O_3 and TiO_X can be detected with Raman spectroscopy. The shifts in wave numbers compared to theoretical calculations made by other authors were assigned to the lattice strain and to the difference in the coefficients of thermal expansion between the substrate and the coating. This knowledge can be a useful tool for the continuing applications of MAX phases.

Keywords
MAX phase
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