The Preparation of Ti_2AlN MAX Phase Coatings and its Oxidation Mechanism under Different Atmosphere

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Ti_2AlN belongs to a family of ternary nano-laminate alloys known as the MAX phases, which exhibit a unique combination of metallic and ceramic properties. In the present work, the dense and high-stability Ti_2AlN coating has been successfully prepared on Ti6Al4V (TC4) substrates through combined cathodic arc/sputter deposition method, followed by heat post-treatment. The oxidation of Ti_2AlN coating and the TC4 substrates were investigated in air and in water vapor at 750 ℃ for 200h. The results indicated that the oxidation processes of both TC4 substrates and the coated samples were accelerated for the presence of steam, resulting in slightly higher mass gains. The oxidation behavior of the bare substrates under different atmosphere exhibited linear kinetics, which indicates a continuous oxidation during its exposure at high temperatures. In contrast, the mass gain was significantly reduced for the coated samples, suggesting that the Ti_2AlN coating can provide an effective protection for the substrates. Moreover, the Ti_2AlN phase can still be found after oxidation in air atmospheres for 200h and the oxide scale showed local Al_2O_3 and rutile TiO_2 growth, namely the oxide did not cover the entire surface of the coating. However, the Ti_2AlN phase disappeared after oxidation in water vapor condition and double layer scales formed in the steam atmospheres, consisting of an outer rich-Al_2O_3 layer and an inner rich-TiO_2 layer. The enhanced oxidation resistance achieved under different condition by the Ti_2AlN MAX phase coatings may satisfy the optimal requirements for many applications in the field of nuclear power plants and aerospace components.

Key words：Ti_2AlN coating; Nano-laminate alloys; Oxidation mechanism; Water vapor;