PO3049

Deposition and characterization of Cr-Al-C thin films for accidents tolerant zircaloy claddings

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$M_{n+1}AX_n$ phases (MAX-phases), ternary compounds where M denotes an early transition metal, A is an element of group A and X is either nitrogen or carbon with n=1, 2, 3, are interesting materials which present several potential applications, for example as protective coating in corrosive environments. These materials exhibit a high corrosion resistance, a thermal-shock resistance as well as a good thermal and electrical conductivity. With the aim of protecting zirconium-based alloys as accident-tolerant fuel (ATF) cladding, low deposition temperatures are needed in order to preserve the clad properties. High power impulse magnetron sputtering (HiPIMS) presents several advantages in comparison to other conventional magnetron sputtering techniques since it improves film density and adherence to the substrate. In this context, HiPIMS facilitates the crystalline films deposition at low deposition temperature due to increased ionization rate and atom mobility released by the sputtered target. Our study aimed at developing robust MAX-phase coatings on zirconium alloys, to protect these alloys against hydrothermal corrosion and high temperature steam oxidation.

In the present work, Cr-Al-C thin films were synthesized by HiPIMS from a Cr_2AlC compound target. The effects of different process parameters, such as the duty cycle and the substrate polarization, on plasma and on the coating development were studied. Amorphous films were formed at room temperature, and crystallized to form MAX-phases after the annealing to 550°C in air. The thermal stability of the structure, microstructure, and mechanical properties of the films were investigated in air and steam at temperatures from 700°C up to 1100°C. This study focuses on the potential of HiPIMS technology for enhancement of structural and mechanical properties of Cr-Al-C coating.

Keywords
MAX Phase
HiPIMS
Protective coating
Properties