PO2019

Evidence of an amorphous niobium oxide phase formation during the oxidation of NbN and Nb-Si-N thin films

Jean-Francois Pierson[1], Alexandre Mège-Revil[1], Pascal Boulet[1]

[1]Institut Jean Lamour / Dpt CP2S, Nancy, France

jean-francois.pierson@ijl.nancy-universite.fr

The outstanding mechanical properties of nitride thin films and the mastering of their industrial deposition process by PVD have allowed their massive spread in the industry, for example for cutting tools applications. Nevertheless, their poor oxidation resistance prevented any further improvement of the lifespan of these cutting tools. As a consequence, studying their behaviour in oxidative conditions is crucial, as it determines their lifespan in tough conditions in a much more important way.
In this study, NbN and Nb-Si-N coatings were deposited by the magnetron co-sputtering of two pure targets of Nb and Si. The phases and the microstructures of the coatings were analysed by XRD and SEM. The oxidation process of the coatings against temperature was studied in situ by XRD under room atmosphere.
An improvement of the oxidation resistance was clearly highlighted with the addition of Si in NbN, whatever the deposition conditions and the microstructure. For all the samples, the crystalline phase was stable up to T_1, at which temperature the nitride peaks intensity start decreasing at each further temperature step up to T_2. At this temperature, the nitride diffraction peaks disappear and then broad Nb_2O_5 peaks develop rapidly. Finally, at T_3, the largest oxide peak gets thinner showing two distinct peaks, which translates the coalescence of the oxide grains. This last phenomenon is especially delayed by addition of Si in NbN. Under our interpretation this delay in the coalescence of the oxide grains would be due to the isolation from one another by amorphous silicon oxide, consequence of a composite structure.
Finally, Raman analyses of films oxidised at temperatures ranging between T_1 and T_2 clearly evidenced a broad Raman band due to the Nb_2O_5 phase, indicating the formation of an amorphous oxide phase.

Keywords
Nanocomposite
in situ XRD
oxidation
Raman