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TiC nanocomposite differences between HiPIMS and DCMS

Alessandro Patelli[1], Marino Colasuonno[1], Diego Giordani[1], Alessandro Surpi[1], Marco Bazzan[2], Giovanni Mattei[2], Valentino Rigato[3]

[1]Veneto Nanotech, Marghera Venezia, Italy [2]Università di Padova, Padova, Italy [3]LNL - INFN, Legnaro (Padova), Italy

patelli@civen.org

The aim of this study is to compare the effect of high power impulse and direct current power supplies in the deposition via magnetron sputtering of TiC/a-C nanocomposites on composition, structure and mechanical properties in industrial conditions with no sample biasing.
Titanium Carbide films were deposited in an industrial close field apparatus (target size 12”x4.9”) by HiPIMS and by DC from a titanium target in acetylene (C2H2) reactive atmosphere. Reactive gas flux was changed in order to obtain C/Ti ratios in the coating from 0.8 up to 2. Emission spectra were recorded highlighting the presence of Hγ emission line only for the HiPIMS process depending on power and pulsing frequency. The deposition rate scaled linearly with the C2H2 flux in the poisoned mode for both DCMS and HiPIMS. Compositional RBS and ERDA characterization also showed lower hydrogen content in HiPIMS coatings than in DC. XRD and TEM characterization showed the presence of TiC nanocrystals with size and spacing dependent on C content surrounded by an amorphous matrix. HiPIMS allows to obtain fine grain TiC nanocrystals at C/Ti ratio closer to 1 than DC.
The difference between the two deposition techniques were highlighted also by the mechanical properties of the coatings, tested by nanoindentation and microscratch. The deposited coatings showed as a function of the deposition process hardness in the range 10-25 GPa and elastic modulus of about 200 GPa, in particular HiPIMS coatings were characterized by higher hardness values while DC samples were always lower than 15 GPa. An increase of hardness and modulus could be observed for C/Ti content around 1.2-1.3. Coefficients of friction showed values lower than 0.2 as a function of carbon coating content and were similar for HiPIMS and DC samples. On the other side adhesion was improved in HiPIMS samples. For C/Ti ratios from 1 to 1.4 the resistivity of the HiPIMS samples was around 400 μΩ cm, while DC samples showed a resistivity more than double (> 1000 μΩ cm).

Keywords
HiPIMS
TiC
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