OR1403

Structure Reinforcement and Phase Change in nc-TiC/a-C:H Coatings Induced by HiPIMS

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Nanocomposite coatings consisting of TiC nanocrystallites embedded in carbon amorphous matrix (nc-TiC/a-C:H) can be tailored to exhibit combination of high hardness and modulus with low friction and wear. HiPIMS depositions usually lead to much higher ionization of the sputtered titanium than DCMS which can alter the deposition process and in turn the properties of the deposited nc-TiC/a-C:H coatings. It was observed that using HiPIMS it was possible to make arc-free deposition of coatings with higher carbon content (> 90 at.%) which was impossible for DCMS (max. 70 at.% C). When DCMS was employed black carbon layers were created on the target, whereas HiPIMS employment lead to a much cleaner target. This was due to significant ionization of sputtered titanium and its back attraction to the target in HiPIMS. Moreover the deposition rate of carbon rich coatings was higher for HIPIMS compared to DCMS for coatings with high carbon content. Lower fraction of the a-C matrix phase was found to be created in HiPIMS deposited nanocomposite coatings with < 55 at.% of carbon as compared to DCMS. HiPIMS deposited coatings also exhibited better stoichiometry of the TiC grains. This shows that HiPIMS promoted carbon incorporation into TiC grains rather than forming of a-C matrix. Lower amount of a-C matrix corresponded with smaller mean grain separation of the TiC grains by the a-C matrix. This lead to overall higher hardness of HiPIMS deposited coatings compared to those deposited by DCMS. The crucial parameters for obtaining hardest coatings were found out to be the TiC grain stoichiometry and small mean grain separation by the a-C matrix corresponding to only a few monolayers of the matrix between the grains. HiPIMS utilization favored this structure enhancement making it a promising method of nc-TiC/a-C:H coating preparation.
This research has been supported by the project CZ.1.05/2.1.00/03.0086 funded by European Regional Development Fund and project LO1411 (NPU I) funded by Ministry of Education, Youth and Sports of Czech Republic.

Keywords
nanocomposite
TiC
HiPIMS