11th International Conference
on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

ICAM2009

Physicochemical and tribological investigations of TiC and VC thin films deposited on Si by DC reactive magnetron sputtering

C. Aguzzoli[(1)*], G. V. Soares[(1)], C. A. Figueroa[(1)], I. J. R. Baumvol[(1,2)]

(1) Universidade de Caxias do Sul, Centro de Ciências Exatas e Tecnologia, 95070-560, Caxias do Sul, RS, Brazil, e-mail: caguzzol@ucs.br
(2) Universidade Federal do Rio Grande do Sul, Instituto de Física, Porto Alegre, 91509-970, Brazil
* Corresponding author.

Abstract – Thin films of transitions metals carbides (TiC, VC, WC) presents many applications in mechanical, and tribological extreme operation conditions. In the present work, these coatings were deposits by reactive magnetron sputtering on single crystal Si(001) substrates. The structural and tribological properties of the films were investigated as a function of different deposition parameters such as methane concentration, substrate temperature and deposition time. The present analysis shows that the cristalinity stoichometry and hardness are strongly affected by substrate temperature during the films deposition.

Carbides of transition metals like TiC, WC and VC in have many applications as coatings in different knowledge areas. These coatings presents excellent tribological and mechanical properties (high thermal and chemical stability, high hardness and biocompatibility) [1,2,3] to be used in applications were surfaces are submitted to extreme tribological operation conditions. Between the many deposition processes used to obtain these hard coatings, physical vapor deposition presents many advantages, since it can be performed at lower temperature, presents high deposition rates and it is widely accepted by the industry [4].

In the present work, TiC and VC thin films were deposited on single crystal Si(001) substrates by reactive magnetron sputtering using methane as the reactive gas. The structural and tribological properties of the films were investigated as a function of different deposition parameters such as methane concentration (0.3-2x10^{-3} mbar), substrate temperature (25-500 ºC) and deposition time (5-80 min).

Rutherford backscattering spectrometry (RBS) were used to evaluate the films composition (stoichometry) and deposition rates. A RBS spectrum of TiC film is show in Figure 1 (a) and of VC film in Figure 1 (b). A variation on the C/Metal ratio was observed with deposition temperature and methane concentration, were both films (VC and TiC) became fully stoichometry for deposition temperature around 400ºC and methane concentrations of 0.5x10^{-3} mbar. We also observed that the films don't present significant impurities concentrations, which can affect it hardness and adhesion to the substrate. The determined deposition rate at 50 W are 3.3 and 2.5 nm.min^{-1} to TiC and VC, respectively. X-ray diffraction analyses (XRD) presented in Figure 2 shows that for low temperature deposition the films present metal solution in the crystalline structure, which is not observed for high temperature deposition. Nanohardness and X-ray photoelectron spectroscopy (XPS) results will also be presented.

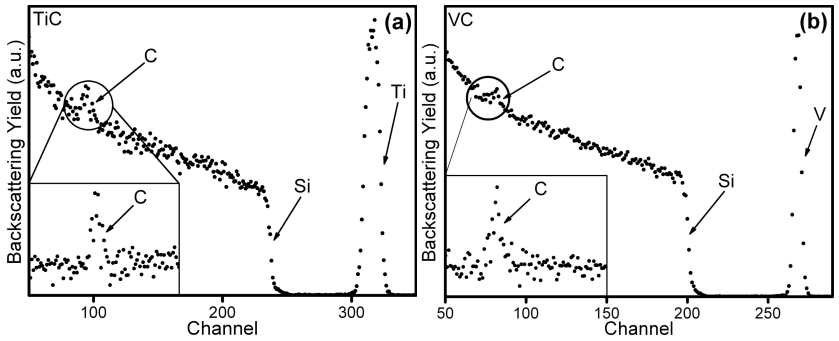

Figure 1: Rutherford backscattering spectrum of 2 MeV He^{+} incident particles spectrum of (a) TiC and (b) VC films on Si.

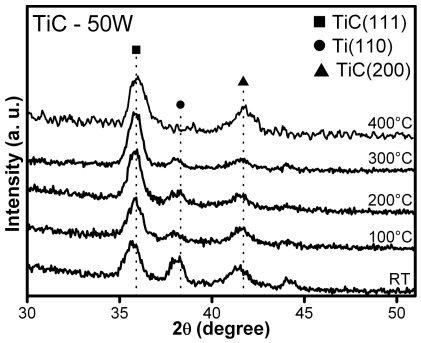

Figure 2: Diffractogram of TiC films deposited at different temperatures.

References

[1] K.N. Strafford. Surface and Coatings Technology, 81, 106, 1996.
[2] M. Brama, N. Rhodes, J. Hunt, A. Ricci, R. Teghil, S. Migliaccio, C. D. Rocca, S. Leccisotti, A. Lioi, M. Scandurra, G. De Maria, D. Ferro, F. Pu, G. Panzini, L. Politi, R. Scandurra. Biomaterials, 28, 595, 2007.
[3] T-H. Fanga, S-R. Jianb, D-S. Chuu. Applied Surface Science, 228, 365, 2004.
[4] D. T. Quinto. Int. J. Refract. Met. Hard Mater. 14, 7, 1996.