Cr_2N – Ag Thin Films – a Short Review

Peter Jurči, Pavel Bílek
Department of Materials, Faculty of Materials and Technology of the STU, Trnava, Paulínská 16, 917 24 Trnava, Slovak Republic, p.jurci@seznam.cz

The current paper summarizes briefly the results obtained by comprehensive investigations of magnetron sputtered Cr_2N thin films with small additions of silver, whereas the pure Cr_2N is used as a reference material. The main aspects reported here are: growth rate of the films, their growth manner, phase constitution, mechanical properties being represented by Young modulus and nanohardness, adhesion on the substrate made from Cr-V ledeburitic steel having a hardness of 60 HRC, tribological performance and effect on the mechanical properties of the substrate.

Keywords: Magnetron sputtering, Cr_2N-Ag thin films, microstructure, mechanical properties, tribological performance

Acknowledgement

This paper is the result of the project implementation: CE for the development and application of diagnostic methods in the processing of metallic and non-metallic materials, ITMS:26220120048. This research was also supported by the grant project VEGA 1/0876/15.

References

[1] AOUADI, S. M., LUSTER, B., KOHLI, P., MURATORE, C., VOEVODIN, A. A. (2009). Progress in the development of adaptive nitride-based coatings for high temperature tribological applications. *Surface and Coatings Technology*, Vol. 204, pp. 962 – 968.

[2] MURATORE, C., VOEVODIN, A. A. (2009). Chameleon Coatings: Adaptive Surfaces to Reduce Friction and Wear in Extreme Environments. *Annu. Rev. Mater. Res*., Vol. 39, pp. 297 – 324.

[3] MURATORE, C., HU, J. J., VOEVODIN, A. A. (2007). Adaptive nanocomposite coatings with a titanium nitride diffusion barrier mask for high-temperature tribological applications. *Thin Solid Films*, Vol. 515, pp. 3638 – 3643.

[4] JAROS, A., SEDLÁK, J., FIALA, Z., CHLADIL, J., DVORACEK, J. (2016). Investigation of the Influence of PVD Coatings Deposited on HSS Milling Cutter. *Manufacturing Technology*, Vol. 16, pp. 506 – 512.

[5] HANES, T., HVIZDOŠ, P., ŤAVODOVÁ, M., KALINCOVÁ, D. HRICOVÁ, J., BEŇO, P. (2014). Coating Surface Roughness Measurement Made On Coining Dies. *Manufacturing Technology*, Vol. 14, pp. 309 - 317

[6] KASINA, M., VASILKO, K. (2012). Experimental Verification of the Relation between the Surface Roughness and the Type of Used Tool Coating. *Manufacturing Technology*, Vol. 12, pp. 27 – 30.

[7] KEJZLAR, P., ANDRSOVA, Z. (2015). Structure of Al-targets Used for PVD Coating in Jewellery. *Manufacturing Technology*, Vol. 15, pp. 553 - 557.

[8] YAO, S. H., SU, Y. L., KAO, W. H., CHENG, K. W. (2006). Evaluation on wear behaviour of Cr-Ag-N and Cr-W-N PVD nanocomposite coatings using two different types of tribometer. *Surface and Coatings Technology*, Vol. 201, pp. 2520 – 2526.

[9] MULLIGAN, C. P., BLANCHET, T. A., GALL, D. (2008). CrN-Ag nanocomposite coatings: Effect of growth temperature on the microstructure. *Surface and Coatings Technology*, 203, pp. 584 – 587.

[10] [MULLIGAN, C. P., BLANCHET, T. A., GALL, D. (2010). CrN-Ag nanocomposite coatings: Tribology at room temperature and during temperature ramp. *Surface and Coatings Technology*, Vol. 204, pp. 1388 – 1394.

[11] MULLIGAN, C. P., GALL, D. (2005). CrN-Ag self-lubricating hard coatings. Surface and Coatings Technology, Vol. 200, pp. 1495 – 1500.

[12] MULLIGAN, C. P., BLANCHET, T. A., GALL, D. (2010). Control of lubricant transport by a CrN diffusion barrier layer during high-temperature sliding of a CrN-Ag composite coating. *Surface and Coatings Technology*, Vol. 205, pp. 1350 – 1355.

[13] MURATORE, C., VOEVODIN, A. A., HU, J. J., ZABINSKI, J. S. (2006). Tribology of adaptive nanocomposite yttria-stabilized zirconia coatings containing silver and molybdenum from 25 to 700°C. *Wear*, Vol. 261, pp. 797 - 805.

[14] HU, J. J., MURATORE, C., VOEVODIN, A. A. (2007). Silver diffusion and high-temperature lubrication mechanisms of YSZ-Ag-Mo based nanocomposite coatings. *Composites Science and Technology*, Vol. 67, pp. 336 - 347

[15] AOUADI, S. M., SINGH, D.P., STONE, D.S., POLYCHRONOPOULOU, K., NAHIF, F., REBHOLZ, C., MURATORE, C., VOEVODIN, A.A. (2010). Adaptive VN/Ag nanocomposite coatings with lubricious behavior from 25 to 1000 °C. *Acta Mater*. Vol. 58, pp. 5326 – 5331.

[16] AOUADI, S. M., BOHNHOFF, A., SODERGREN, M., MIHUT, D., ROHDE, S. L., XU, J., MISHRA, S. R. (2006). Tribological investigation of zirconium nitride/silver nanocomposite structures. *Surface and Coatings Technology*, Vol. 201, pp. 418 – 422.

[17] BASNYAT, P., LUSTER, B., KERTZMAN, Z., STADLER, S., KOHLI, P., AOUADI, S., XU, J., MISHRA, S. R., ERYILMAZ, O. L., ERDEMIR, A. (2007). Mechanical and tribological properties of CrAlN-Ag self-lubricating films. *Surface and Coatings Technology*, Vol. 202, pp. 1011 – 1016.

[18] JURCI, P., BOHOVICOVA, J., HUDAKOVA, M., BILEK, P. (2014). Characterization and wear performance of CrAgN thin films deposited on Cr-V ledeburitic tool steel. *Materiali in technologije/Materials and technology*, Vol. 48, pp. 159 – 170.

[19] JURCI, P., DLOUHY, I. (2011). Coating of Cr-V ledeburitic steel with CrN containing a small addition of Ag. *Appl. Surf. Sci*., Vol. 257, pp. 10581 – 10589.

[20] JURČI, P., KUSÝ, M., PTAČINOVÁ, J., KURACINA, V., PRIKNEROVÁ, P. (2015). Long-term Sub-zero Treatment of P/M Vanadis 6 Ledeburitic Tool Steel – a Preliminary Study. *Manufacturing Technology*, Vol. 15, pp. 41 - 47.

[21] BÍLEK, P., JURČI, P., HUDÁKOVÁ, M., PAŠÁK, M., KUSÝ, M., BOHOVIČOVÁ, J. (2014). Cr_2N-7Ag nanocomposite thin films deposited on Vanadis 6 tool steel. *Appl. Surf. Sci*., Vol. 307, pp. 13 – 19.

[22] BÍLEK, P., JURČI, P., PODGORNIK, B., JENKO, D., HUDÁKOVÁ, M., KUSÝ, M. (2015). Study of Ag transport in $Cr_2N_{0.61}$-7Ag nanocomposite thin film due to thermal exposition, *Appl. Surf. Sci*., Vol. 357, pp. 317 – 327.

[23] BÍLEK, P., JURČI, P., NOVÁK, M., HUDÁKOVÁ, M., ČAPLOVIČ, L. (2015). Tribological and mechanical properties of Cr_2N–11Ag-coatings deposited on Cr–V ledeburitic steel, *Wear*, Vol. 340 - 341, pp. 47 – 52.

[24] BÍLEK, P., JURČI, P., DULOVÁ, P., HUDÁKOVÁ, M., PTAČINOVÁ, J., PAŠÁK, M. (2015). Interaction of Cr_2N and Cr_2N/Ag thin films with CuZn-brass counterpart during ball-on-disc testing. *Materiali in Tehnologije/Materials and Technology*, Vol. 49, pp. 429 – 433.

[25] MILLER, D. L., KUBISTA, K. D., RUTTER, G. M., RUAN, M., De HEER, W. A., FIRST, P. N., STROSCIO, J. A. (2010). Structural analysis of multilayer graphene via atomic moiré interferometry. *Physical Review B*, Vol. 81, pp. 125427-1 – 125427-6.

[26] BÍLEK, P., JURČI, P., ČAPLOVIČ, L., HUDÁKOVÁ, M., PTAČINOVÁ, J. (2015). Microstructure of Cr_2N-11Ag nanocomposite thin film ddeposited on Vanadis 6 tool steel. *Key Engineering Materials*, Vol. 647, pp. 121 – 128.

[27] EHIASARIAN, A. P., MUNZ, W.D., HULTMAN, L., HELMERSSON, U., PETROV, I. (2003). High power pulsed magnetron sputtered CrNx films. *Surface and Coatings Technology*, Vol. 163-164, pp. 267 - 272.

[28] CUNHA, L., ANDRITSCHKY, M., PISHOW, K., WANG, Z. (1999). Microstructure of CrN coatings produced by PVD techniques. *Thin Solid Films*, Vol. 355-356, pp. 465 – 471.

[29] LAMASTRA, F. R., LEONARDI, F., MONTANARI, R., CASADEI, F., VALENTE, T., GUSMANO, G. (2006). X-ray residual stress analysis on CrN/Cr/CrN multilayer PVD coatings deposited on different steel substrate. *Surface and Coatings Technology*, Vol. 200, pp. 6172 – 6175.

[30] DJOUADI, M. A., NOUVEAU, C., BEER, P., LAMBERTIN, M. (2000). Cr_xN_y hard coatings deposited with PVD method on tools for wood machining, *Surface and Coatings Technology*, Vol. 133-134, pp. 478 - 483.

[31] KÖSTENBAUER, H., FONTALVO, G. A., KECKES, J., MITTERER, C. (2008). Intrinsic stresses and stress relaxation in TiN/Ag multilayer coatings during thermal cycling. *Thin Solid Films*, Vol. 516, pp. 1920 - 1924

[32] VILLAR, P. CALVERT, L. D. (1989). *Pearson's Handbook of Crystallographic Data for Intermetallic Phases*. Vol. 1. Metals Park, Ohio, American Society for Metals.

[33] KUTSCHEJ, K., MITTERER, Ch., MULLIGAN, C. P., GALL, D. (2006). High-temperature tribological behaviour of CrN-Ag Self-lubricating Coatings. *Advanced Engineering Materials*, Vol. 8, pp. 1125 – 1129.

Paper number: M2016134