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Analysis of mechanical and tribological behavior of nitrogen ion-implanted chrome thin films

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The properties and structures of the surfaces of the materials are very important for science and technology. Electroplated chromium coatings have been used as protective layer in industry for several years due to its high hardness, corrosion and wear resistance. The carcinogenic character of hexavalent Cr is well-known and its use has been banished from several countries. Thus, there is a constant research for new materials and technologies to replace chromium electroplated coatings. Cr nitrides have good oxidation and corrosion resistance, and excellent wear resistance in high temperature, speed and applied pressure conditions. Cr-N produced by PVD method has been considered as a good substitute for electroplated coatings. This work aims at the analysis of mechanical and tribological properties of Chrome thin films deposited by Magnetron Sputtering technique and subsequently treated with Plasma Immersion Ion Implantation (PIII), without changing the chamber system. The deposition system used inert gas atmosphere and metallic target with 99,99% Chrome, resulting in a clean process, with no toxic waste. SAE 1070 carbon steel sample disks of 15 mm diameter and 3 mm thickness were used as substrates. The chromium films were deposited with average power of 100 W, working pressure in the order of 10^{-2} mbar for one hour. For ion implantation by plasma immersion, different values of implantation time, energy and pulse were used; additionally, in two experiments, deposition and implantation were carried out with the sample-holder inside a stainless steel tube, which assumes the function of cathode. Characterization techniques used were: XRD, SEM, EDS, AFM, XPS, tribological tests and nanoindentation. XRD analysis showed the formation of CrN after PIII treatment. Tribological tests showed reduction in friction coefficient for some experimental conditions of thin films treated, although still not achieving significant reduction in wear. The analysis by XPS showed that the ratio N/Cr is higher in thin films treated inside the tubular cathode, indicating more effective implantation in this set-up. Additional results on toughness, morphology and composition of the films will also be shown in the conference.

[1] Ueda et al, *Surface & Coatings Technology,* v.**229**, p. 97-104, (ago 2013)
[2] Mello et al, *Surface & Coatings Technology,* v. **204**, p. 2971-2975, (2010)

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