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Microstructural Characterization of Hardened AISI 4140 using CrN/CSi Coatings

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The design of internal and external layers in coatings is one of the main topics of interest today [1]. On the one hand we look for a material with good properties of tenacity and adhesion and on the other with high hardness and tribological properties when it comes to applications of wear-resistance and corrosion resistance [2-3]. Some investigations had been carried out previously to determine the correlation between the microstructure and the properties of the deposition materials as well as the type of technique chosen [4-6]. In the first part of this study we performed a microstructural characterization of single-phase coatings CrN/SiC deposited by PVD tecnique on a steel substrate.

The CrN coatings were produced in a BAI 1200 machine at Oerlikon Balzers in Mexico. They were deposited on 4140 alloy steel substrate with a high vacuum and at a temperature about 450 °C for 2 hours. Then, SiC coating were deposited on CrN layer introducing the precursor hexamethyldisilazane (HMDS) CH3SiNHSiCH3 and argón as a process gas inside the plasma reactor, at varying pressures of the order of 0.8 atm. The ionization potential fluctuated between 700V and 900V, and the substrate temperature was 600ºC for the argon process. The film growth rate on average is approx. 1μm / h, and its average hardness is approx. ~ 9 on the Mohs scale.
The presence of SiC and CrN films on the surface of AISI 4140 steel was confirmed by Scanning Electron Microscopy (SEM), Energy Dispersive Spectroscopy (EDS) and X-Ray Diffraction (XRD) techniques. Figure 1 shows cross sectional SEM micrograph of CrN and SiC films as well as EDS maps of Si, C, Cr and N on AISI 4140 steel. The XRD scans (Figure 2) confirmed the presence of a single phase coatings SiC and CrN formed in the AISI 4140 steel. The chemical composition of the sample surface is observed in Figure 3 and it is given in Table 1 confirming the presence of silicon carbide on its surface. These results demonstrate that the process of PVD applied to AISI 4140 steel formed superficial layers CrN/SiC.

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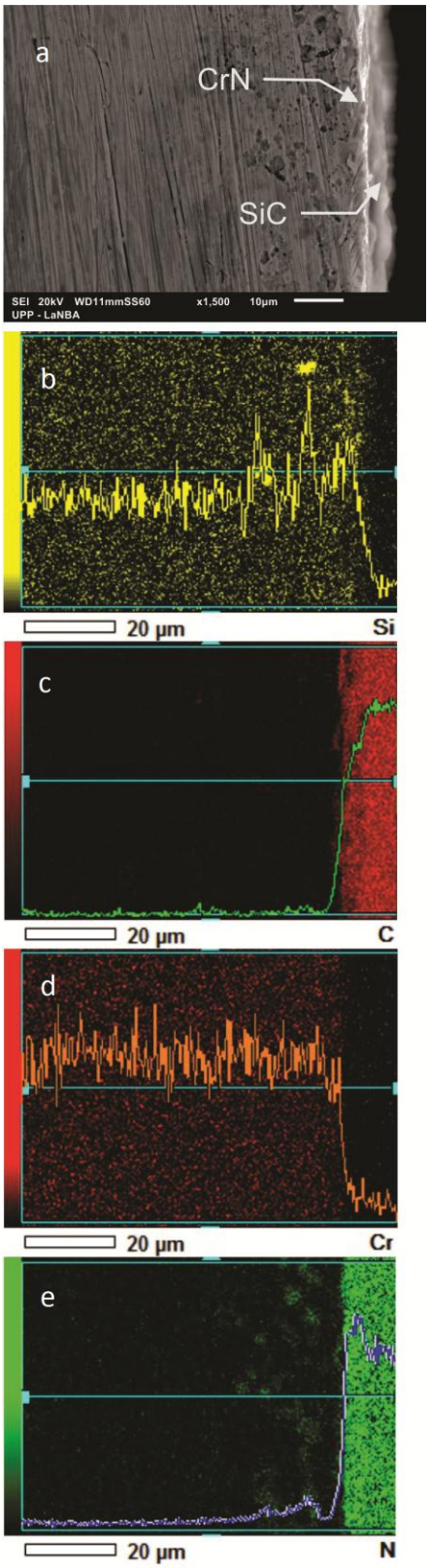

Figure 1. a) cross sectional SEM micrograph and EDS maps of b) Si, c) C, d) Cr, e) N.

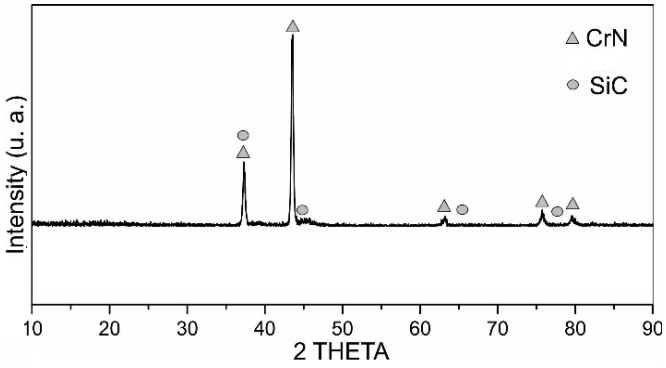

Figure 2. XRD diffraction patterns of SiC and CrN coatings.

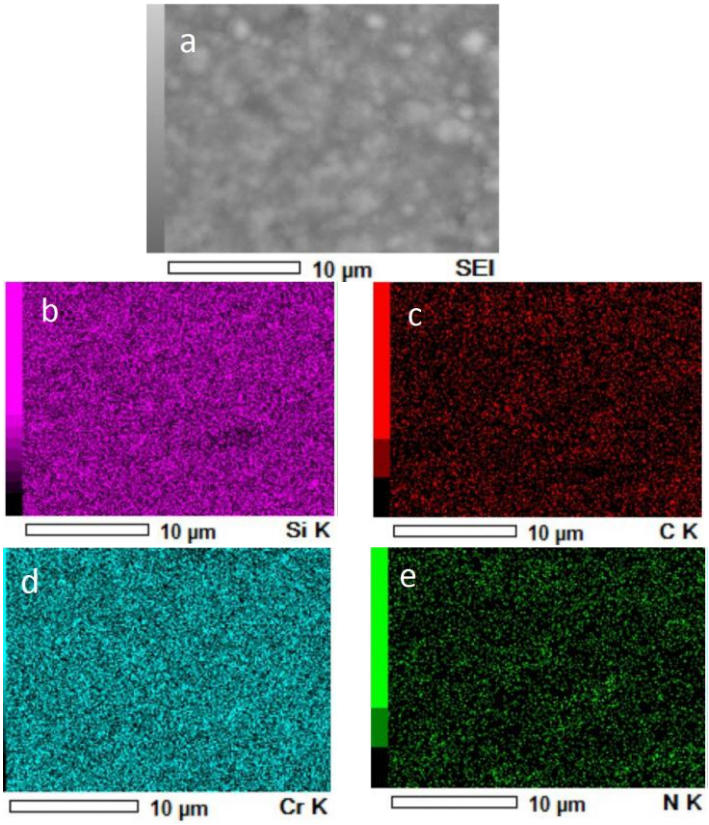

Figure 3. EDS maps of a) sample surface, b) Si, c) C, d) Cr, e) N.

Element	C	Si	N	Cr
Wt.%	18.89	18.82	14.25	48.04

Table 1. Chemical composition of the sample surface

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