Microsc. Microanal. 28 (Suppl 1), 2022
doi:10.1017/S1431927622003191

Electroless Ni–P Coatings Containing $Al_2O3-TiO_2/TiC$ Reinforcement

A. Santos-Beltran[1]*, V. Gallegos-Orozco[1,2], M. Santos-Beltrán[1], I. Ronquillo-Ornelas[1], H.M. Medrano-Prieto[1] and R. Martinez-Sanchez[3], J.A.Brito-Chaparro[1]

[1.] Universidad Tecnológica de Chihuahua Sur, Carretera Chihuahua-Aldama Km 3, Chihuahua, Chih., México.
[2.] Instituto Tecnológico de Chihuahua, Ave. Tecnológico #2909, Chihuahua, Chih., México.
[3.] Centro de Investigación en Materiales Avanzados, Avenida Miguel de Cervantes Saavedra 120, Complejo Industrial, Chihuahua, Chih., México.
* Corresponding author: audelsantos@gmail.com

The industrial applications of composites cover different fields of the mechanical industry, engineering, aeronautics, naval, mining, agriculture and nuclear [1]. Composite coatings with better performance are being studied using electroless deposition [2]. Electroless Ni–P deposition is an autocatalytic process where the substrate develops a potential in a plating bath containing metallic ions, reducing agent, complexing agent, stabilizer and other components. To improve the metal coating characteristics, fine and hard particles are added in an electrolytic or electroless bath, this kind of coatings show excellent mechanical properties as hardness and wear resistance including corrosion. In this work, electroless Ni–P was used to co-deposit fine ceramic particulate reinforcement to prepare composite coating on a 304-steel. The Al_2O_3 ceramic, due to its high elastic modulus, high wear, high hardness, good chemical stability and strong adaptability is used in the engineering materials as reinforcing material [3]. The addition of TiC and TiO_2 into the Al_2O_3 matrix improve the hardness resistance, fracture toughness, and thermal shock resistance. In the first stage, Al_2O_3-TiO_2/TiC reinforcing compound was fabricated via powder metallurgy route consisting mechanical milling followed by compaction and subsequent sintering treatment, using Al, C and TiO_2 as raw materials. At a later stage, the reinforcing compound was dispersed into the Ni matrix via electroless Ni–P method. Microhardness test were used to evaluate the mechanical properties of coating. The effect of sintering time and composition on microhardness of coatings were evaluated.

From quantitative phase X-ray diffraction analysis, the reinforcing composite is composed of approximately 55 wt. % Al_2O_3, 44% TiO_2 and only 1 wt. % of TiC. Figure 1 shows the X-ray diffraction pattern of the Al_2O_3-TiO_2/TiC reinforcing compound. Morphology and microstructure of Ni coatings containing Al_2O_3-TiO_2/TiC compound reinforcement, were studied by scanning electron microscopy and energy-dispersive X-ray spectroscopy (EDS). Figure 2a shows the SEM backscattered electrons (BSC) image and Figure 2b, the EDS analyses. The image shows round Ni grains of about 500 nm in diameter and finely dispersed dark particles of about 100 nm, corresponding to the Al_2O_3-TiO_2/TiC reinforcement compound dispersed in the Ni matrix.

Figure 3 shows the effect of C content and sintering time on microhardness of coated samples (not sintered samples are include). The graph shows an evident increase of the microhardness with C at 2h of sintering.

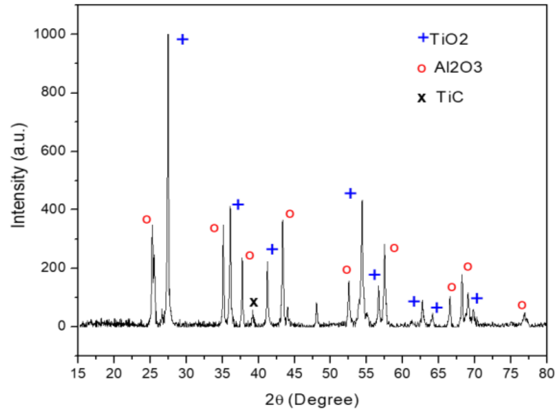
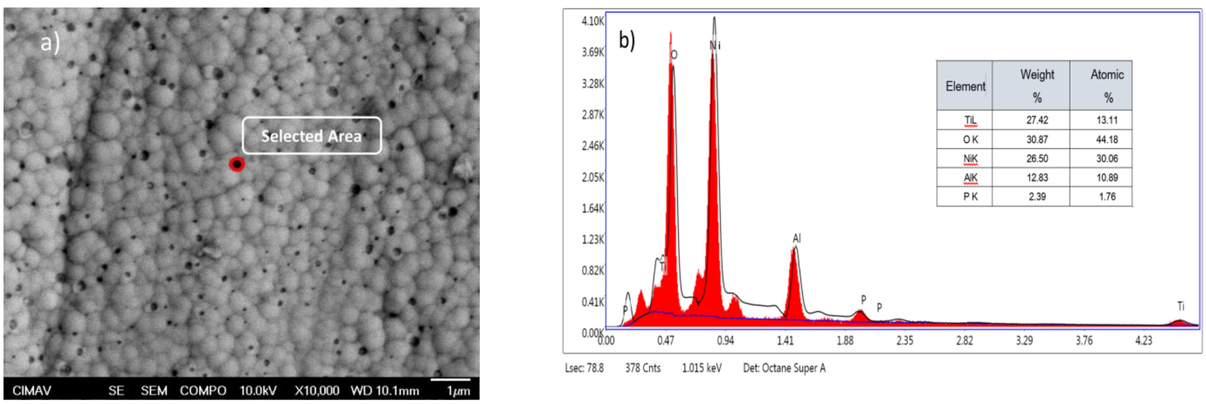


Figure 1. X-ray diffraction pattern of the $Al_2O_3/TiO_2/TiC$ reinforcing compound.



Element	Weight %	Atomic %
TiL	27.42	13.11
O K	30.87	44.18
NiK	26.50	30.06
AlK	12.83	10.89
P K	2.39	1.76

Figure 2. **a)** SEM compositional image and b) energy-dispersive X-ray spectroscopy analysis

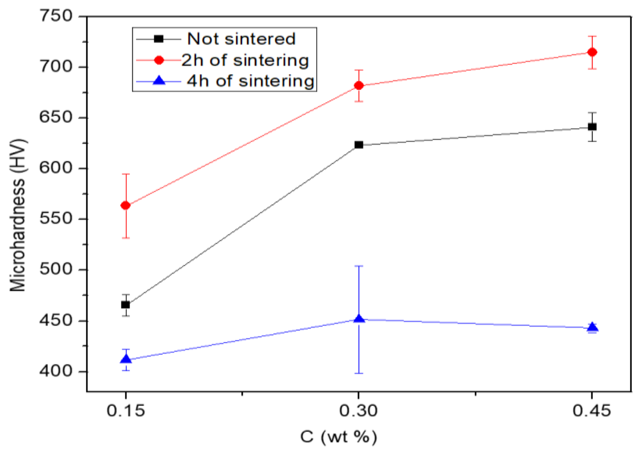


Figure 3. Effect of C content and sintering time on microhardness.

https://doi.org/10.1017/S1431927622003191 Published online by Cambridge University Press

References:

[1] Yangchuan Cai, Zhen Luo, Mengnan Feng, Zuming Liu, Zunyue Huang, Yida Zeng, Surface and Coatings Technology, **291** (2016) p. 222-229. https://doi.org/10.1016/j.surfcoat.2016.02.033

[2] Agarwala, R.C. & Agarwala, Vijaya. Electroless alloy/composite coatings: A review. Sadhana, **28**, (2003) p. 475-493. doi:10.1007/BF02706445

[3] A. Abdel Aal, Z.I. Zaki, Z. Abdel Hamid, Materials Science and Engineering A **447** (2007) p. 87–94. doi:10.1016/j.msea.2006.10.036