Tribological and Nanoscopic Investigation of Manganese Phosphate Conversion Coatings

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Introduction

Manganese phosphate conversion coatings form a strongly adhering, dense and non-metallic layer of hureaulite crystals on suitable steel surfaces (Figure 1a). Therefore, they are widely applied as corrosion protection and bonding agent for paints, as well as for tribological applications where they enhance the effect of lubricants and additionally show self-lubrication and protective properties. According to common literature and datasheets, such coatings can be applied only onto steels with up to approximately 1 wt% of Chromium, without further cause and details. This work presents new findings on the formation and tribological properties of such coatings on steels with higher chromium content of up to 3 wt%.

Experimental

Tribological characterisation of these coatings comprised scratch tests and specific high load and reciprocating test setups under dry and lubricated conditions. In order to describe the coatings, analysis and investigation methods like transmission electron microscopy, electron backscatter diffraction and nanoindentation were employed.

Results

The tribological investigations pointed out severe differences in durability and wear resistance of the coatings in dependence of substrate and coating process [1]. As shown in Figure 1b, on a steel with 3% of Chromium a cracked and amorphous layer with undesirable properties is formed. Adjustment of the bath composition allowed to manufacture a tribologically superior coating which consist of amorphous and crystalline phases as demonstrated by transmission electron microscopy.

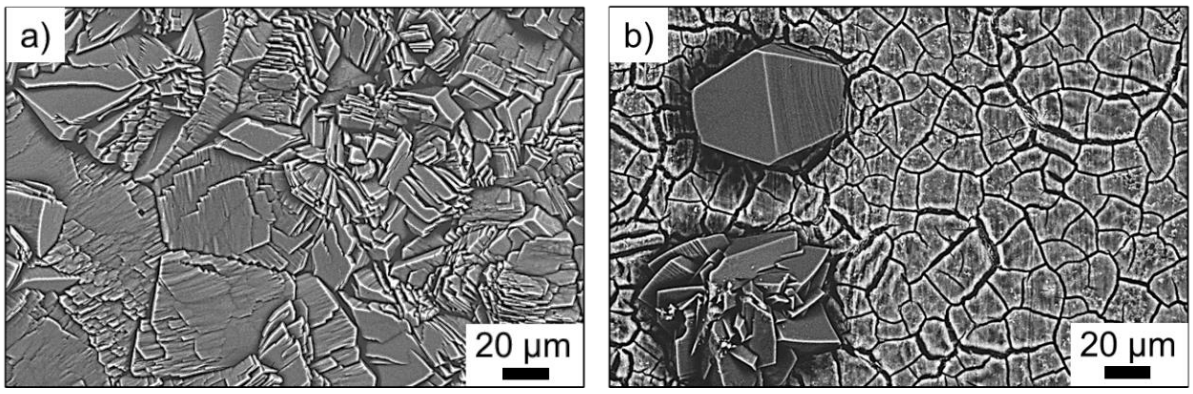

Figure 1: Manganese phosphate conversion coatings on steel; a) steel substrate with 1% Cr; b) steel substrate with 3% Cr.

1. Nevosad, A., Molnar, W. & Schwarz, S. Effect of Chromium Content in the Steel Substrate on the Coating Formation and Tribological Properties of Manganese Phosphate Coatings. *J. Mater. Eng. Perform.* (2021) doi:10.1007/s11665-021-05994-9.

Acknowledgements

The work presented was funded by the Austrian COMET Programme (Project InTribology, no.872176) and carried out at the "Excellence Centre of Tribology" (AC2T research GmbH).