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F14: Surface Modification and Functionalisation

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Plasma nitriding plus oxidizing as a protective treatment for AISI 4140 steel

AISI 4140 is a typical chromium molybdenum medium alloy steel, widely used as construction steel for machine components. Plasma nitriding has been applied as surface hardening treatment with success but the nitrided layer isn´t always good for corrosion. Plasma nitriding plus oxidizing is proposed as an environmentally friendly alternative which can assure a good wear resistance and also provide a corrosion protective surface layer.

In this investigation, heat treated AISI 4140 steel was plasma nitrided in a 15 hours process at 500 C and then oxidized in the same chamber using two different temperatures: 400 C and 500 C, 1 hour duration in a water steam atmosphere. Microstructure was analysed by optical and electronic microscopy and XRD. Wear resistance was tested in a pin on disk machine using alumina as counterpart and corrosion resistance was evaluated in salt spray fog tests and electrochemical tests in NaCl solution, comparing with only nitrided samples of the same steel.

The oxide layer was 0.5 microns width, and the nitrided compound layer beneath, 3 microns width. XRD revealed the presence of magnetite and in a minor proportion, hematite in the oxide layer, and gamma iron nitrides in the nitrided layer. In the pin on disk tests with 3 N load no significative variations occurred between the oxidized samples compared with the only nitrided ones, neither in volume loss nor in friction coefficient.

On the other hand, in the salt spray fog tests, only the nitrided samples oxidized at 400 C did not present signs of general corrosion after 100 h test. In the electrochemical tests, both oxidized samples had a nobler corrosion potential and a pseudo passive region, showing a better corrosion behaviour of the oxidized samples compared to the nitrided ones, which suffered from active dissolution in the chloride solution.

Presenter: Prof. Sonia Brühl, Ph.D