Corrosion Resistance and Formability of Ultra-thin Plasma Polymer Films on Galvanised Steel

Abstract:

Corrosion resistant polymer/zinc interfaces are of high importance for organically coated or adhesively bonded galvanised steel substrates. Plasma technology like e.g. plasma enhanced chemical vapour deposition has become an industrial relevant and environmentally friendly dry process at atmospheric or reduced pressures to modify oxides and oxide covered metal surfaces.

Stretch forming of galvanised steel coated with ultra-thin SiO_2-like plasma polymer films with varying film thickness was performed to study the formation of defects in the plasma polymer films and their relevance for the corrosion protection properties of the coated substrate. The study of the interfacial electrode potentials and the correlated cathodic de-adhesion kinetics of polymer coated thin film modified substrates showed that the interfacial oxygen reduction is already strongly inhibited by SiO_2-like films with a thickness of 10 nm. However, uniaxial stretching of these thin film coated metal substrates leads to a formation of nanoscopic defects, which are characteristic for highly crosslinked films on ductile substrates. Microscopic, electrochemical and spectroscopic methods were combined to correlate the size and distribution of these nanoscopic defects with the macroscopic corrosive de-adhesion mechanisms and the corresponding kinetics for organically coated substrates.