EFFECT OF CURING TIME AND TEMPERATURE ON THE CORROSION PROTECTION PROPERTIES OF HYBRID COATINGS

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It is widely known that due to their efficient properties as coupling agents, organosilane molecules represent an interesting and environmentally friendly alternative in the field of surface conversion treatment. In fact it is widely reported that hybrid sol-gel films can be applied onto galvanized steel to increase the adhesion between the metallic substrate and an organic coating. In addition it is reported in the literature that also the corrosion protection properties conferred to the metallic substrate by these hybrid layers themselves is noteworthy [1]. In fact, these are able to act as a physical barrier against water and aggressive ion diffusion to the substrate [2] decreasing the corrosion reaction rate on the metal surface. To improve the corrosion protection properties of these hybrid layers it is possible to embed suitable nanoparticles in the matrix. In a previous study [3] the effect of the sonication times on the rheological properties of different water-based organosilane–nanoclay solutions was evidenced. In particular, the beneficial effect of the presence of about 1-2wt% of sodium montmorillonite in the hybrid matrix was evidenced.
In this work organosilanes derived sol-gel films containing clay nanoparticles applied on hot dip galvanized steel (HDG) were studied. In particular the effect of different curing times (2, 5, 10, 15 minutes) and different curing temperatures (90°, 150°, 180°C) on the protection properties of the hybrid layer was investigated. After an etching treatment carried out in an alkaline solution, the HDG samples were dipped into the hydrolysed organosilane solution, prepared from glycidoxypropyltrimethoxysilane, tetraethoxysilane and methyltriethoxysilane with 2wt% of sodium montmorillonite. Different curing time and temperature treatments were performed. First of all the stability and the rheological properties of the organosilane solution was investigated by means of shear stress/shear strain analysis and Z-potential measurements. The effect of the curing time and temperature on the different materials was investigated using FT-IR spectroscopy.
The corrosion protection properties of the different sol-gel layers were investigated mainly by means of electrochemical techniques such as potentiodynamic curves and electrochemical impedance spectroscopy (EIS). The electrochemical tests discriminated the different samples highlighting the effect of the different curing time and temperature.

[1] D. Zhu, W.J. van Ooij, *Corros. Sci.* 45 (2003) 2177
[2] M. Fedel, M. Olivier, M. Poelman, F. Deflorian, S. Rossi, M.-E. Druart, *Prog. Org. Coat.* 66 (2009) 118-28
[3] M.-G. Olivier, M. Fedel, V. Sciamanna, C. Vandermiers, C. Motte, M. Poelman, F. Deflorian, *Prog. Org. Coat.* 72 (2011) 15– 20