Elaboration of bisphenol A polybenzoxazine coatings for barrier protection applications on aluminum substrate

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Aluminum alloys are used in different fields such as aeronautics, automotive- or space applications because of their numerous advantages, amongst which their low weight. Nevertheless, these alloys are sensitive to corrosion and, therefore, need to be protected. Recently, polybenzoxazines have gained an increasing interest due to their potential of combining the excellent properties of traditional epoxy- or phenolic resins. This class of polymer offers highly attractive properties such as high glass transition temperatures, low absorption of water, near zero shrinkage [1], good dielectric properties [2].

In this work, a commercial bisphenol A benzoxazine was chosen to assess the barrier properties of an applied coating. Several solutions were prepared with different starting concentrations in benzoxazine, dissolved in acetone. The optimal solvent concentration of the solution was determined on basis of rheological behaviour. Thick coatings (from 5 to 20 microns) were obtained by dip coating on a 1050 aluminum substrate.

A heat treatment at 180°C followed by a step at 200°C was then performed to polymerize the benzoxazine. The structural transformation during thermal curing was followed by Fourier Transform Infrared spectroscopy (FT-IR) and the polymerization degree was calculated from data obtained by Differential Scanning Calorimetry (DSC). Dielectric Analysis (DEA) and Thermogravimetric Analysis (TGA) showed a particular behaviour related to a partial decomposition at 180°C and to the creation of intermediary ionic and volatile species. Moreover, during the consecutive curing step at 200 °C, an increase of the electrical insulation of the benzoxazine related to the polymerization was showed by DEA. Finally, the barrier protection was evaluated by electrochemical impedance spectroscopy (EIS) during 30 days in 0.5 M NaCl solution. The results showed an improvement of the impedance modulus from 10^4 $\Omega.cm^2$ for an uncoated aluminum to 10^9 $\Omega.cm^2$ with a 10 microns thick polybenzoxazine coating.

[1] H. Ishida, D. Allen - *Physical and Mechanical Characterization of Near-Zero Shrinkage Poly benzoxazines* - Journal of Polymer Science Part B: Polymer Physics – 34 (1996) 1019– 1030

[2] M.C. Tseng, Y.L. Liu - *Self-assembled benzoxazine-bridged polysilsesquioxanes exhibiting ultralow-dielectric constants and yellow-light photoluminescent emission* – Polymer – 51 (2010) 5567-5565