Effect of Temperature on the Behaviour of Titanium Dioxide in Polyethylene Teraphthalate Protective Coatings on Electrolytic Chromium Coated Steels

E. Zumelzu [(1)*] F. Rull[(2)], C.Ortega[(1)]

(1) Instituto de Materiales y Procesos Termomecánicos, Universidad Austral de Chile, Casilla 567, Valdivia, Chile, ezumelzu@uach.cl.
(2) Dpto. Física de la Materia Condensada, Universidad de Valladolid, Spain.
*Corresponding author.

Abstract - The present study analysed the behaviour of titanium dioxide (TiO2) in polyethylene teraphthalate (PET) polymer coatings on ECCS steel plates employed in the manufacturing of food containers (Fig.1). Also, this work determined the thermal source affecting rutile distribution in the PET coating [1]. Measurements at parallel intervals from the surface to the metal interface were made by Raman and micro Raman vibrational spectroscopy techniques to characterise the rutile distribution in the PET thickness (Fig.2). Finally, scanning electron microscopy observations determined the changes on the surface properties of the coating (Fig. 3).

The present work evaluated the effect of temperature on the behaviour of rutile in the PET coating, and determined if this effect originated in the manufacturing conditions of the ECCS plates and treatments to induce PET adherence on the steel, or was rather a consequence of industrial canning processes.

In this sense, controlled simulation trials to evaluate the effect of temperature on PET, particularly on the titanium dioxide distribution in the plate thickness during the canning process, were performed. The changes were analysed by vibrational spectroscopy to quantify the surface sections potentially unprotected against the environmental actions and to characterise the microdamages on the PET polymer that alter the protective functionality of the coating. Representative trials at 80°C and for 30 min in a closed environment simulating the food canning process were performed. The control samples were not thermal treated and the PET coating was characterised to determine its condition after the manufacturing process. This study employed a Raman device Spectrometer Kaiser Holospec f/1.8i, spectrum range 100-3800 cm-1, and a resolution of 4 cm-1; CCD Andor DV420A-OE-130; and laser Melles-Griot 0.5-lhp-151, He-Ne 632'8 nm. The samples were macroanalysed by making the laser beam strike perpendicular to the surface with a Raman of 785 nm.

Also, cross-sections of the samples were microanalysed parallel to the coating by means of the Raman device at 633 nm, obtaining spectra every 10 μm at different points starting from the PET surface until reaching the ECCS interface. Also, a scanning microscope, LEO 400, was used to characterise the inner surface of the PET substrate. The results obtained demonstrated the need to control the thermal effects during the manufacturing processes.

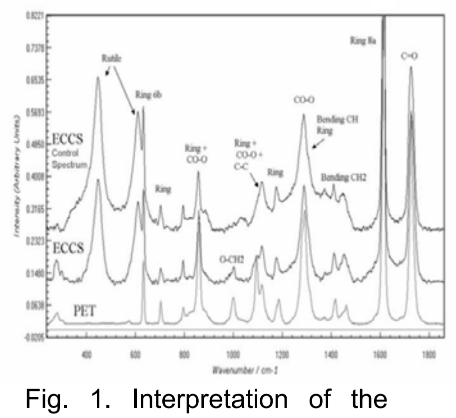

Fig. 1. Interpretation of the materials substrate by Raman Espectroscopy.

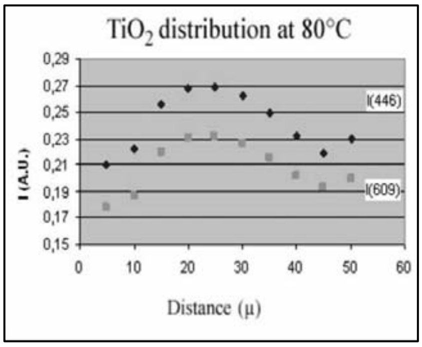

Fig. 2. Rutile distribution in PET Coating profile at 80 ºC and two adsorption peak (446 and 609 cm-1).

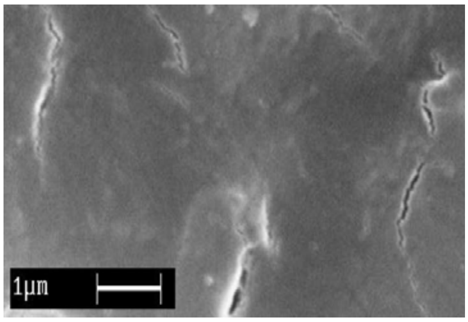

Fig. 3. Surface microcracks on PET caused by persistent action of the environmental.

Acknowledgements

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References

[1] E Zumelzu, F Rull, C Cabezas, C Ortega, Surface Engineering 25, 2 (2009 111-115.