Tavares da Costa, M V., Bolinsson, J., Fayet, P., Gamstedt, E K. (2019)
Mechanical investigations to obtain adhesive and cohesive properties of the ultrathin metal coatings on polymers films
In:

MECHANICAL INVESTIGATIONS TO OBTAIN ADHESIVE AND COHESIVE PROPERTIES OF THE ULTRATHIN METAL COATINGS ON POLYMERS FILMS

Marcus Vinícius Tavares da Costa [1], Jessica Bolinsson [2], Pierre Fayet [3] and E. Kristofer Gamstedt[1]

[1] Uppsala University, Division of Applied Mechanics, Department of Engineering Sciences, Box 534, SE-751 21 Uppsala, Sweden, marcus.tavares@angstrom.uu.se and kristofer.gamstedt@angstrom.uu.se.

[2] Tetra Pak AB, DSO Packaging Materials, Ruben Rausings gata, SE-22186 Lund, Sweden, jessica.bolinsson@tetrapak.com.

[3] Adhemon Sarl, Thin Technology, Avenue Edouard-Dapples 20, 1006 Lausanne, Switzerland, pierre.fayet@adhemon.com.

Key Words: *ALD coating, Polymer substrate, Adhesion strength, Cohesive strength.*

Metal oxide coating with a nanometer scale thickness on flexible polymer substrates is an interesting combination for food packaging applications. This combination provides an enhancement of the barrier performance in the carton package (Fayet et al., 2015) . A concern is the cracking of the brittle coating when subjected to tension and bending in the manufacturing process. Such cracks can affect the permeability. In this study, the coatings were produced by atomic layer deposition of metal oxides, with thickness values between 4 and 20 nanometers on poly(ethylene terephthalate) substrate films.

This presentation therefore focuses on examining multiple cracking in those coatings through fragmentation tests (Andersons et al., 2007) by *in situ* tensile loading in a table top scanning electron microscope to track the crack accumulation and subsequently to calculate adhesive and cohesive properties, such as the interfacial shear and coating strength. Furthermore, we are going to show high-resolution microscope images of ridge cracking (Li et al., 2018), which is mainly caused by compressive deformation due to the transverse Poisson contraction. Then, we demonstrate how to obtain an interfacial fracture toughness parameter between coating and substrate making use of a micromechanical model and ridge crack dimension.

In this work, we also explore a mixed numerical-experimental method to quantify the interfacial strength based on observed delamination emanating from ridge cracking, as schematically outlined in Figure 1. The advantages and disadvantages of the experimental methods and numerical simulation will be addressed, as well as the accuracy of the assumptions in their underlying models.

The obtained adhesive and cohesive parameters could be used in quality assessment for different types of coatings and processing conditions. They also have the potential to be used in predictive modelling of crack accumulation and loss of barrier properties when in folding and stretching in the manufacture of food and beverage containers.

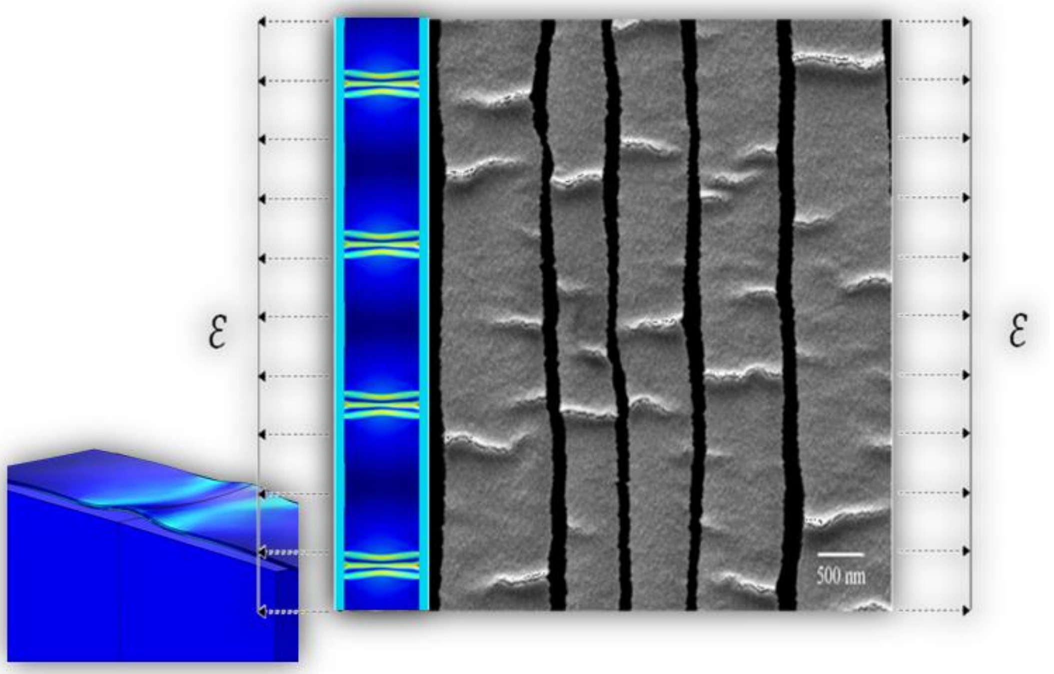

Fig. 1: TiO_2 coating of 6 nm thick on top of PET film stretched at 30% tensile strain.