Origin of "framing effect" of liquid coatings: capillary approach

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Materials are often coated for functional or esthetic purposes with liquid coatings processes. However liquid coating application may result in surface irregularities in final film due to physico-chemical phenomena such as Marangoni effect or due to surface topography. Objectives of this study is to understand the formation of the so-called "framing effect", a surface defect present at the edges of coated substrates, and the levers to reduce it. This study enables a deep understanding on liquid coating formation dynamics and more precisely on solutal and thermal phenomena involved during film formation. Film characteristics, surface topography as well as multi-physical aspect of evaporation process are taken into account to understand final coating topography and framing effect dynamics

Keywords (from 3 to 5 max): Coating, framing effect, film formation, evaporation, Marangoni effect

1. Introduction

In many industrial applications, liquid coatings are used to add technical functionalities or esthetic properties to materials. Wet-processing application of these multi-components fluids may result in surface irregularities due to process conditions, environmental conditions or coating characteristics when applied to substrates [1]. "Framing effect" is a coating defect due to capillary phenomena resulting in a liquid excess at the edges of coated substrate which can be troublesome in particular regarding visual perception. Recent studies consider liquid viscosity, film thickness as major parameters for framing effect formation [1]. Objectives of this study is to show that coating composition and its physicochemical properties have also an influence on it taking into consideration capillary effects and Marangoni-type material flow [2].

2. Materials & Methods

2.1. Model coating preparation

Model coatings with known components and quantities have been formulated and characterized (surface energy, viscosity, composition with chromatography). They have been sprayed with pneumatic application on thermoplastic substrates such as PC-ABS with known edge geometry.

2.2. Evaporation monitoring

Solvent evaporation has been characterized with deflectometric and gravimetric measurements as well as thermal analyses in order to study evaporation kinetics. In parallel, instantaneous velocimetry measurements evaluation and visual characterization of fluid motion have been performed with PIV (Particle Image Velocimetry) technique.

3. Results & Discussion

It has been showed that solvent volatility and surface tension additives have a major influence on framing effect dynamics and therefore in its final topography.

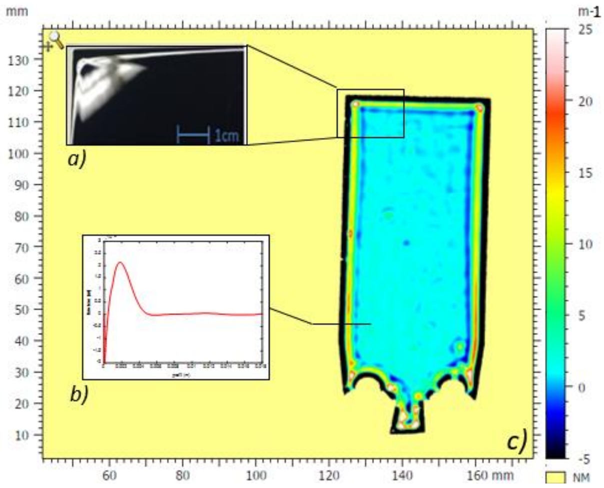

Figure 1: a) framing effect picture, b) typical framing effect profile, c) deflectometric curvature map

Dynamic deflectometry results allowed a comprehensive evidence of coating flow throughout evaporation process. Moreover, PIV study enabled an understanding on coating internal dynamics in relation to coating physico-chemical parameters. Correlation were also made between Marangoni number, calculated for each coating formulation and PIV results.

4. References

[1] Sommer et al., "Investigation of Coating Liquid Layer Behaviour at Curved Solid Edges", Applied Mechanics and Materials 831, 2016, 126–143

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