Characterization of interfaces morphology and properties in polymer blends: AFM measurements assisted with FE simulations to dissociate the effects of intrinsic and structural parameters

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It is now unanimously admitted that waste has to become a significant resource to modestly participate in addressing the environmental burden. Yet, with this much needed emphasis on recycling, the challenges associated with sorting post-consumer polymeric parts suggest that non-miscible polymer blends have to be considered as potential structural end materials for a wide range of applications. The associated scientific challenges are thus to better understand and predict the behavior of such complex materials. More specifically, in immiscible blends the morphology and properties of interfacial regions (interfaces with or without interphases) are crucial and need to be reliably characterized. To that end, the dialogue between Atomic Force Microscopy (AFM) observations and Finite Elements (FE) calculations is further pursued [1]. Indeed, while AFM is a powerful tool allowing the microstructural and micromechanical characterizations of nanostructured systems, it remains an indirect measurement technique affected by multiple factors inherent to nanoindentation, such as the surface preparation for instance [2]. Thus, through the dialogue between experimental AFM measurements and FE analysis, the effects of key metrics triggering the complex modulus reduced from AFM measurements and characterizing the viscoelasticity will be studied.

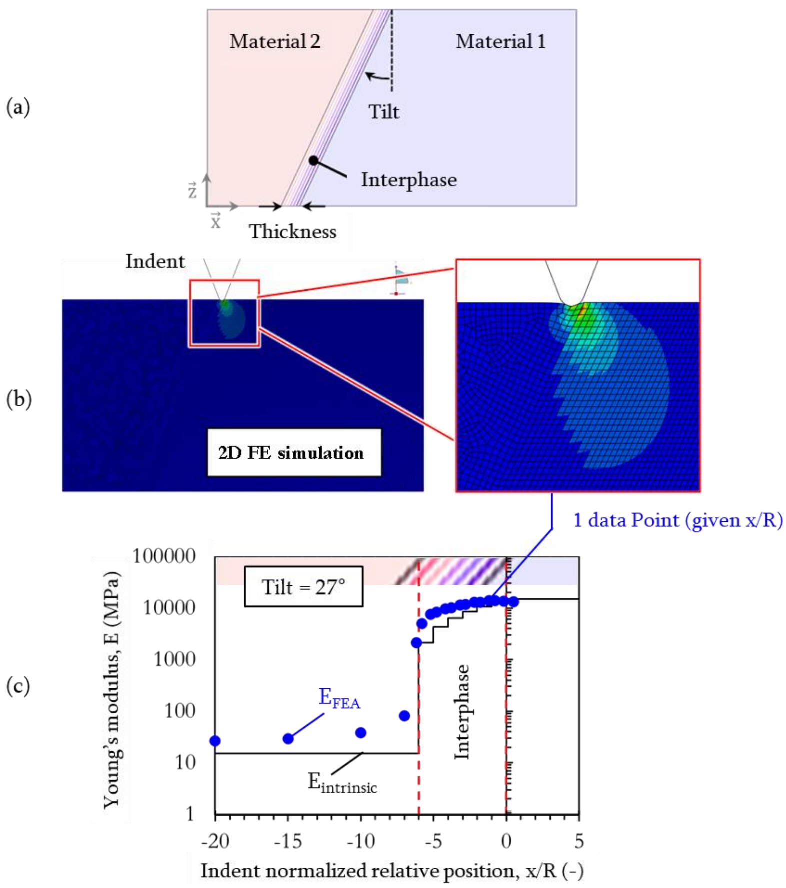

Figure 1:

(a) Geometrical model of a titled interphase,

(b) Finite Element 2D elastic simulation evidencing the Von Mises stress distribution under the tip of the indent,

(c) Spatial evolution of the local intrinsic moduli ($E_{intrinsic}$) and the moduli reduced from the FE simulations (E_{FEA})

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In depth, the role of geometrical parameters (the free surface topology, the interface width and orientation …) and material ones (phases and interphases intrinsic properties), and their conjugated interplay have to be further understood. An illustration of the 2D finite element model developed and the associated elastic results is presented in figure 1 for a simplified case of a perfectly flat surface with a tilted interphase evidencing the difference between the intrinsic (input) and reduced (FEA) elastic moduli (Figure 1c).

References :

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Key words :
Polymer blends, interphase, AFM, FEA,