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ROLE OF THE INTERPHASE ON THE STABILITY FLOW ON MULTILAYER POLYMER IN REACTIVE COEXTRUSION PROCESS

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Coextrusion technologies are commonly used to produce multilayered composite sheets or films with a large range of applications from food packaging to optics. The contrast of rheological properties between layers can lead to interfacial instabilities during flow. Important theoretical and experimental advances have been made during the last decades on the stability of compatible and incompatible polymers using a mechanical approach. However, few works were dedicated to the physicochemical affinity between the neighboring layers. The present work deals with the influence of this affinity on interfacial instabilities for functionalized incompatible polymers. We have experimentally confirmed, in this case, that the weak disturbance can be predicted by considering an interphase of non-zero thickness (corresponding to interdiffusion/reaction zone) instead of a purely geometrical interface between the two reactive layers.

As a first part, we present a generic study which allows us to obtain a better handle of this process with reactive multilayered materials. Rheological behavior of multilayer coextruded of cast films was investigated to probe: (i) the competition between polymer/polymer interdiffusion and interfacial reaction of functionalized polymer and (ii) the influence of various parameters in relationship with the process: temperatures, contact time, shear rate and residence time… The contribution of interface/interphase effect has been studied along with the increase of the number of layers. The results show that the variation in dynamic modulus of the multilayer system reflects both diffusion and chemical reaction. The results were rationalized by comparing the obtained data with some existing theoretical models. Finally, and in order to quantify the contribution of the effect of the interface/interphase with a specific interfacial area, an expression was developed to take into account the interphase triggered between the neighbouring layers and allowed us to estimate its thickness at a specific welding time and shear rate.

As the second part, we present an experimental strategy to optimize the process by listing the different parameters controlling the stability of the reactive multilayer flows. The plastic films of two, three and five layers were coextruded in symmetrical and asymmetrical configurations in which PA6 is a middle layer. Indeed, for reactive multilayered system, the interfacial flow instability can be reduced or eliminated, for example, by (i) increasing the residence time or temperature in the coextrusion bloc (for T over reaction temperature) and (ii) reducing the total extrusion flow rate. Furthermore, the role of viscosity ratio, elasticity ratio, and layer depth of the stability of the interface were also investigated coupling to the physicochemical affinity. Hence, based on this analysis guide-lines for stable coextrusion of reactive functionalized polymers can be provided.

Despite the progress made, the following questions remain open: 1) How does the physico-chemical affinity influence the stability of multilayer system? and 2) How can one perform physical and numerical modeling of the role of compatibilisation in the theoretical and experimental stability charts?