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Phase Inversion in Immiscible Blends of PE and Reactive EVA

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Thermoplastic vulcanizates based on polyethylene (PE) and ethylene vinyl acetate copolymer (EVA) at ratio 40/60 wt % have been dynamically cross-linked in a batch mixer. A transesterification reaction was carried out in the presence of a cross-linking agent and an organometallic catalyst. Phase inversion occurred during the reactive mixing, i.e. the EVA major phase, initially the matrix, was finally dispersed in the PE minor phase. Such blends exhibit the processing properties of thermoplastics due to the matrix of PE, and the characteristics of elastomers due to the high content of cross-linked EVA. The aim of the study was to understand how the rheological properties of both components and the processing conditions control the phase inversion and affect the final properties. The effects of temperature and rotational speed of the mixing rotors were studied to obtain the finest morphology. A shoulder was observed in the evolution of the torque of the mixer during the reaction and it was related to phase inversion. Phase inversion was also observed for a 40/60 PE/ EVA reactive blend in simple shear flow using a rotational parallel plate rheometer. The use of a low viscosity PE was found to favor phase inversion due to a more favorable initial viscosity ratio resulting in a finer morphology of the elastomeric phase. Finally, the possibility of using rheological models to predict phase inversion will be discussed. We will present a critical review of empirical expressions used to predict phase inversion and of recent constitutive equations proposed to predict morphology changes under processing conditions. We will stress the limitations of these equations and discuss the specific problems associated to reactive blending. Finally, challenges and trends for future research will be discussed.