Experimental and Numerical fracture of cracks emanating from different types of flaws in thin polymer films

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Abstract: Fracture mechanical Mode I tensile testing has been performed on an oriented polyproplyne film used in packaging industry. Physical Tensile testing for the continuum material has been performed to observe the material strength and to extract continuum material properties for numerical analysis. Fracture mechanical testing of different shaped notches is performed to observe the failure initiation in the material. A brittle-like failure was shown in the polypropylene film while the low density polyethylene presented a highly ductile behavior. A finite element method (FEM) strategy has been successfully developed to perform numerical analysis of polymer films. The developed FEM model gives an accurate and approximate method to compare and analyze the experimental and numerical results. The obtained results have shown a very fine similarity under theoretical, experimental and numerical analysis. Depending on crack geometry different shape crack effects showed the transferability of localized stresses at different points around the crack. Fracture surface and fracture process is analyzed using scanning electron microscope (SEM). Brittle failure with small deformation and presence of small voids and their coalescence has also been shown in SEM micrographs for LDPE material. The methods discussed will help classify different groups of materials and can be used as a predictive tool for the crack initiation and crack propagation path in packaging material, especially thin polymer films.

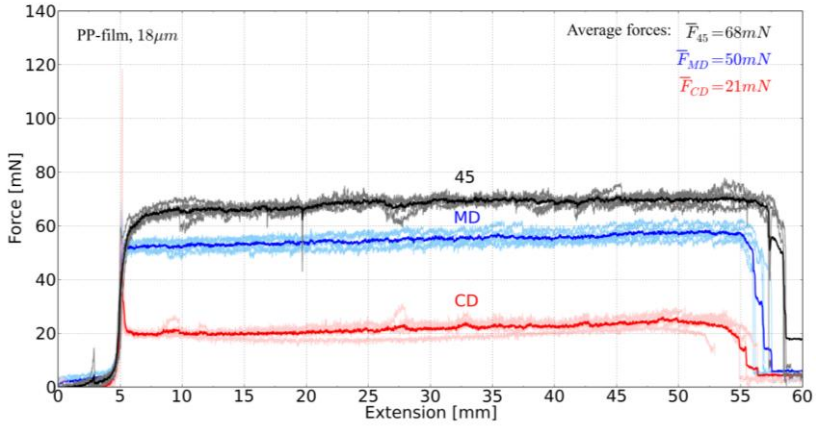

Figure 1. Trouser tear test in material direction 45°, MD and CD for PP-film, force vs. extension. Bold lines represent mean curves for each material direction.