590a Influence of Branching Distribution on the Physical Properties of High-Density Polyethylene

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In this study, three sets of two-component blends from various narrow-MWD polyethylenes were prepared with multiple compositions within each set of blends. These blends were deliberately prepared such that the branching (SCB or short-chain branches from 1-hexene co-monomer) was present exclusively on either the high or the low molecular weight component. This allowed us to probe the exclusive influence exerted by the SCB distribution profile on many physical properties of polyethylene. While many previously published reports discuss the influences exerted by molecular weight, crystallinity and SCB content on the properties of PE, we believe that this is the first report that elucidates the exclusive influence exerted by branching distribution. This investigation has tremendous practical implications as many commercial PE applications include either blending of reactor product (from series or parallel reactors) or of polymers with and without SCB to tailor product performance (1, 2).

In a previous study (3), we had discussed the influence exerted by such preferential placement of branches on the isothermal and non-isothermal crystallization kinetics of polyethylene. In this study, our experiments indicate a tremendous influence exerted by branching distribution on many physical properties measured on compression molded and oriented (cast films) specimens. Specifically, while selective placement of branches (crystallizable defects) along the longer molecules do not influence the instantaneous tensile properties, they exert a strong influence on many ultimate failure properties of compression molded and oriented products. The specific physical properties that strongly favor branch placement along the longer molecules include:

· The tensile stress at break. · Low ultimate extensibility (strain at break). · Razor-notched Charpy impact energy. · Ductile-to-brittle transition temperature. · Resistance to slow crack growth (PENT). · Cast film impact toughness. · Cast film MD and TD tear resistance.

Based on the crystallization model presented earlier (3), we propose that the enhanced physical properties of polymers with preferential placement of branches (crystallizable defects) along their longest molecules are a consequence of their extensive inter-connectivity between the lamellar crystals.

REFERENCES

(1) F. W. Bailey and W. M. Whitte, United States Patent 4,461,873 (1984); United States Patent 4,547,551 (1985). (2) R. K. Krishnaswamy, Q. Yang, United States Patent Applications (2004). (3) R. K. Krishnaswamy, Q. Yang, L. Fernandez-Ballaster and J. A. Kornfield, Polymer, In Press (2005).