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Tuning Properties of Semi-Crystalline Polymers at Constant Crystallinity: Adjusting Rigid Amorphous Fraction and Crystallization Conditions by Solid-State Shear Pulverization PHILIP BRUNNER, JOHN TORKELSON, Northwestern University — Semi-crystalline polymers consist of both crystalline and amorphous regions, the latter of which can be subdivided into rigid amorphous fraction (RAF) and mobile amorphous fraction. The RAF does not undergo a glass transition at the measured Tg but may remain rigid up to the melting temperature of the crystalline regions. This means that RAF can quantified by DSC measurements related to the change in heat capacity in going from the glassy to liquid state upon heating. We have discovered that RAF levels in some semi-crystalline polymers can be altered dramatically by solid-state shear pulverization although the crystallinity level remains constant. We take advantage of this to demonstrate how permeation characteristics and mechanical properties of semi-crystalline polymers may be significantly altered by SSSP while maintaining constant crystallinity levels. Examples include nylon 11 in which oxygen permeability can be decreased by 50% due to an increase in RAF, with the permeability reduction caused by nearly equal effects of RAF on solubility and diffusivity. Additionally, major changes in tensile properties of nylon 11 and polycaprolactone can be correlated with changes in RAF at constant crystallinity.

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