584f Production of Well Dispersed Polymer Blends and Nanocomposites Using Renewable Polymers with Solid-State Shear Pulverization

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The emphasis on creating biodegradable polymers has increased due to environmental concerns with petroleum based materials. As a result, several naturally renewable polymer systems have become commercially available. Some of these polymer systems, like poly(lactic acid), have properties comparable with petroleum based polymers, but at a much higher cost. Other polymer systems, like starch, are very inexpensive, but have fairly poor mechanical properties. One way to provide a successful polymeric material at a reasonable cost is by creating blends or nanocomposites.

For this work, solid-state shear pulverization (SSSP) was used to process the polymeric materials. During SSSP, the polymer is kept well below the transition temperature to maintain the polymer in solid form. This eliminates any thermodynamic limitations associated with blend formation, creating a well dispersed system. In this work, the morphology and dispersion of several polymer systems were examined. The polymer blends studied include polyethylene/thermoplastic starch, polycaprolactone/thermoplastic starch, and poly(lactic acid)/thermoplastic starch. Processing via SSSP yielded smaller dispersed phase particle size in the blends compared with melt processed material. For example, an average dispersed phase domain size of 9 μm was achieved in the PE/thermoplastic starch from SSSP, while the average dispersed phase size was 96 μm from melt mixing. Nanocomposites were created using thermoplastic starch and clay. Small angle x-ray scattering demonstrated exfoliation of the clay sheets in the nanocomposites produced via SSSP.