Multi-Component Polymer Processing for Novel Applications

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In the polymer processing, control of the shape of products as well as control of the high order structure in the products is crucial since the characteristics of polymer products are known to vary significantly depending on their structural parameters such as molecular orientation and crystallinity. In this presentation, utilization of multi-component polymer processing for the better controllability of shape and high order structure will be discussed mainly focusing on the fibers and films of unique functionality.

Optical functionality can be introduced to the polymer products through the control of refractive index and its anisotropy. Interference colored fiber was developed by incorporating the alternating multi-layered structure of two polymers into fiber cross-section. Thickness of each layer was less than 100 nm. Reflective polarizing film (RPF) for the enhancement of the brightness of liquid crystalline display is a typical example for the utilization of multilayered structure with optical anisotropy. We have also tried to produce the RPF by embedding the aligned bicomponent fibers with controlled refractive index anisotropy in the UV cure resin. In this case, good controllability of molecular orientation of sheath and core components in the high-speed melt spinning process was utilized.

Control of molecular orientation also leads to the development of fibers with unique thermal-mechanical characteristics. Highly crimped fibers were produced through melt spinning of side-by-side bicomponent fibers consisting of recycled and virgin poly(ethylene terephthalate), PET. During the pelletizing process of PET flake, polymer was modified through the incorporation of long chain branching. Such modification lead to the enhancement of the strain-hardening behavior. On the other hand, Mutual interaction of two components for the structure development behavior in the melt spinning process was utilized to fabricate sheath-core bicomponent fibers consisting of polyethylene and polypropylene. The fiber, which have a unique characteristics of spontaneous elongation upon annealing, is widely applied for the production of non-woven fabrics of soft touch.

All thermoplastic fiber-reinforced composites can be prepared through the compression molding of sheath-core bicomponent fibers consisting of high melting temperature core and low melting temperature sheath. Composites with structural gradient along the thickness was prepared mimicking the structure of bamboo. Realizing that compression molding of bicomponent fiber is possible if the sheath part is consisting of a crystalline polymer in an amorphous state, fiber-reinforced single-polymer composite was prepared through the compression molding of sheath-core bicomponent fibers consisting of low and high molecular weight PET.