2. Die-Drawing of Polypropylene Particulate Composites

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The process of drawing heated solid composites through a converging die can produce expanded or voided composites with a high level of molecular orientation that can serve as thermoplastic lumber for applications in the construction industry. Unlike traditional lumber which has the same material properties before and after the shaping step, some material properties of the thermoplastic lumber are developed together with the product shape in the die-drawing process; this feature adds another layer of complexity to product design and process design. The goal of on-going research is to relate critical elements of the microstructure such as void fraction and molecular orientation in die-drawn products to temperature and strain rate history and to relate the properties to the microstructure in a practical fashion.

![Fig. 2 Tensile modulus of drawn material vs. draw ratio with a die area ratio of 2](image)

We have investigated fundamental aspects of microstructure development during the process of hot solid die-drawing recently and found that some aspects of microstructure like the void fraction start to level off at lower draw ratios or strains while others like the tensile modulus continue to increase with draw ratio—see Figure 2. We have observed that significant void growth occurs in the elastic regime as well as the plastic regime of polymer deformation while significant molecular orientation occurs only in the plastic regime.