Melt spinning of thermotropic liquid crystalline pitch: Study of process variables

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Thermotropic liquid crystalline (mesophase) pitch exhibits planar orientation of the mesogens, which makes them suitable as a precursor for producing carbon fibers with significant graphitic content. The precursor fibers can be produced by melt-spinning, a rapid commercial process that enables reduction of processing costs. One of the main challenges in melt spinning of mesophase pitches is the understanding of the relationships between the process conditions and the microstructure of the resulting pitch fibers, which in turn controls properties of the final product.

Among various process conditions, the draw down ratio (DDR, defined as the ratio between the winding speed and the extrusion speed) is of particular importance because it has a direct effect on reducing the as-spun fiber diameter, which is critical for improving fiber strength. In the current study, the combined effect of capillary diameter of the multi-hole spinneret and the draw down ratio is being investigated to obtain precursor fibers of a given diameter. For flexible chain polymers, larger DDR is known to improve modulus and tenacity of fibers. However, there is only limited evidence for mesophase pitch, which suggests an opposite trend. Therefore, current studies are directed toward investigating the effect of DDR on tensile and transport properties of resulting carbon fibers derived from synthetic and petroleum-derived pitches.