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Flow-Induced Crystallization Precursor Structure in Entangled Polymer Melt.[1]

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Flow-induced crystallization has long been an important subject in polymer processing. Varying processing conditions can produce different morphologies, which lead to different properties. Recent studies indicated that the final morphology is in fact dictated by the initial formation of crystallization precursor structures (i.e., shish kebabs) under flow. In this talk, factors that affect the shish-kebab formation in entangled polymer melts are systematically reviewed, including the concept of coil-stretch transition, chain dynamics, critical orientation molecular weight, phase transition during shish and kebab formations. In particular, recent experimental results from in-situ rheo-X-ray studies and ex-situ microscopic examinations have been presented to illustrate several new findings of flow-induced shish-kebab structures in polymer melts. (1) The shish entity consists of stretched chains (or chain segments) that can be in the amorphous, mesomorphic or crystalline state. (2) The kebab entity mainly arises from the crystallization of coiled chains (or chain segments), which seems to follow a diffusion-control growth process. (3) A shish-kebab structure with multiple shish was seen in the ultra-high molecular weight polyethylene (UHMWPE) precursor. Based on the above results and recent simulation work from other laboratories, a modified molecular mechanism for the shish-kebab formation in entangled melt is presented.

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