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Slippage, Cavitation and Sharkskin in Polymer Melts

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Slippage in polymeric materials has been a subject of intense interest for three primary reasons. First, it is strongly interconnected with extrusion instabilities that commonly occur in polymer manufacturing (sharkskin, gross melt fracture, stick-slip). Second, the effect can be quite strong, the magnitude of slippage can become an appreciable fraction of the largest velocity of the flow. Third, molecular scale theoretical models have been developed that relate the slippage to shear stress, polymer molecular weight and polymer-surface interactions, all of which the experimentalist can control. We have utilized near-field velocimetry to demonstrate slippage within the first 100 nm from a solid wall and found a stress dependent transition from weak to strong slippage as well as a dependence on interfacial interactions. We have also shown that slippage can occur at a polymer-polymer interface when the interaction between them is weak. Allowing slippage at a polymer-polymer interface dramatically reduces the undesirable flow instability known as sharkskin. In the case of mixed flow boundary conditions, we have observed that the polymer can cavitate at the wall.