129e The Dynamics of a Model for Nematic Lcps in a Simple Shear Device: the Ericksen and Deborah Number Cascades

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We consider the behavior of the Doi-Marrucci-Greco model for nematic liquid crystalline polymers in a simple shear device over a range of Erickson and Deborah numbers from the Leslie-Erickson limit up to Deborah numbers of order O(10). The computational results show behavior that is qualitatively identical to the Erickson and Deborah number cascades that were observed experimentally by Larson and Mead. Characteristic of the Ericksen number cascade, the model exhibits three flow regimes at low to moderate shear rates: steady linear shear flow at low shear rates, steady roll cells at intermediate shear rates, and irregular flow and orientation patterns at moderate shear rates. Of particular interest is that, given sufficiently high shear rates, the flow structure is accompanied by the formation of +/- 1 and +/- 1/2 strength disclinations. The former appear at lower Erickson / Deborah numbers. At higher Erickson / Deborah numbers, both types of disclinations occur. The disclinations form very near to the top and bottom boundaries of the flow cell, but not at the walls. As the flow structure develops, disclinations originating near the wall propagate into the domain via convection, and continue to form across the flow as the regular roll cell structure gives rise to irregular flow and orientation patterns. Both types of disclinations tend to form between adjacent roll cells when these are present. Finally, at shear rates large enough to inhibit tumbling of the average molecular orientation, the solution no longer contains disclinations or roll cells, but retains some structure in the flow direction that has the visual appearance of stripes with periodicity in the orientation distribution in the vorticity direction.