EFFECT OF VISCOSITY CONTRAST IN STRUCTURE -RHEOLOGY RELATIONSHIP IN SHEARED LAMELLAR MESOPHASE IN 3-D

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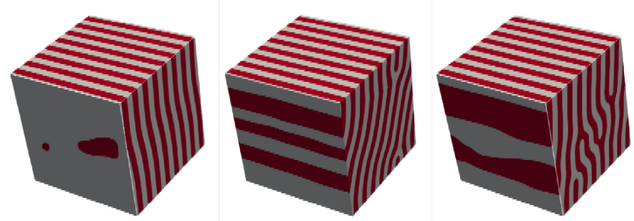
The structure-rheology relation in a sheared lamellar mesophase is studied by varying Ericksen number Er (viscous/elastic stress), Schmidt number Sc_o (momentum/mass diffusivity) and difference in viscosity between hydrophilic and hydrophobic phase(μ_1) using a mesoscale model. It is observed that the coarsening process is not altered by viscosity contrast for any Er or Sc, because the dominant mechanism is diffusion at early times, but the scaled effective viscosity evolution (scaled by well aligned span wise configuration viscosity) is different for systems with contrast at both before and after segregation . After layer formation, the scaled effective viscosity decreases slowly for systems with high viscosity contrast, because the process is affected by momentum transfer. The effect of viscosity contrast is prominent at a moderately high value of $\mathrm{Er} = 0.03$, where the stiffness of the layers leads to a steady state defect density in layers aligned in the span-wise direction (shown in Fig.**??**) at low Sc_o which is otherwise perfectly aligned state for no contrast. However, viscosity contrast reduces defect density at higher Sc_o but still the effective viscosity is enhanced.



(a) (b) (c)

Figure 1: steady state configuration at $\mathrm{Sc}_o = 0.33$, $\mathrm{Er} = 0.03$ (a) $\mu_1 = 0.0$ (b) $\mu_1 = 1.0$ (c) $\mu_1 = 2.0$

This significant change in long time layer arrangement and effective viscosity due to introduction of viscosity contrast is not present at higher $\mathrm{Er} = 0.3$. The dominant contribution of shear stress is from viscous effects for lesser stiff layers and presence of partially formed layers in velocity gradient direction brings the viscosity below 1. When Er is decreased further ($\mathrm{Er} = 0.003$) at low $\mathrm{Sc}_o = 0.33$, the alignment direction changes from span-wise to wall normal direction with tilted layers, though the viscosity decease's scaling with time after coarsening is same as that at moderately high Er. Despite having a direction change of alignment being seen on introduction of contrast, long time limit viscosity is hardly altered though transient effective viscosity is seen to be much higher as usual due to having stiff layers in low Er limit.The change in layer arrangement at steady state could be because the flow of stiff layers through low viscosity regions results in the layer tilt and alignment in wall normal direction whose signature is much slower decrease of effective viscosity after segregation.However this change in steady state layer normal direction is missing for higher Sc_o in this regime again signifies the importance of higher momentum transfer rate in alignment process.