Supplemental Information for

Dynamic orientation transition of lyotropic lamellar phase at high shear rate

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In the supplemental information, we show SAXS data for the sample with B/H=0.30 and 0.34, which are typical system showing the L_α(C)/L_α(A) orientation transition and the onion phase formation, respectively. In the sample with B/H=0.30, we can also see characteristic SAXS profiles showing the presence of the intermediate structure.

1 SAXS profiles for the sample with B/H=0.30

Typical SAXS profiles and lamellar spacing d as a function of shear rate for the system with B/H=0.30 at T=25°C are shown in fig. 1. This systems shows the orientation transition at $\dot{\gamma}_{c/a}$=300s^{-1} (see Fig. 6 in the main text). Lamellar spacing d at B/H=0.30 slightly decreases with increase in the shear rate, while at B/H=0.32 it slightly reduces at low shear rate and stays almost constant at high shear rate. Reduction in the lamellar spacing d with the shear rate was also reported for the hyper swollen lamellar phase. Ratio of the reduction at B/H=0.30 is only a few % which is the same order as that observed in dilute lamellar system [1]. We did not see obvious reduction of d at the orientation transition point as expected from theoretical argument. Kato *et al.* found that the lamellar spacing drastically changes as the shear rate is approached to a specific value where the segregation of the lamellae occurs [2, 3]. Slight decrease in d with the shear rate may indicate that the suppression of the undulation fluctuation is gradually induced but not suddenly at the critical shear rate. However, almost constant value at high shear rate indicates that the suppression of the undulation fluctuation is not only the driving source for the orientation transition.

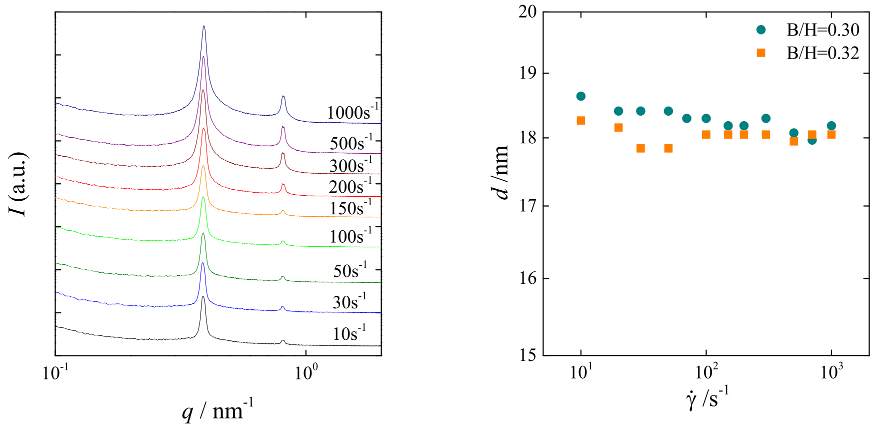

Figure 1: Left panel: SAXS profiles as a function of shear rate. SAXS was measured for samples with B/H=0.30 at T=25°C. Each profiles are vertically shifted for the eyes. Right panel: Lamellar spacing d at different B/H ratio as a function of the shear rate.

2 SAXS profiles for the sample with B/H=0.34

Figure 2 shows the SAXS profiles as a function of shear rate for the system with B/H=0.34 at T=25°C. The lamellar spacings d at B/H=0.34, 0.36, and 0.38 are also shown as a function of the shear rate. In these systems, several orientation transitions occur as a function of the shear rate. On the contrary to B/H=0.30, lamellar spacing d does not show the shear rate dependence and stays constant over whole shear rate range. The lamellar spacing d is not influenced by those transitions in these samples.

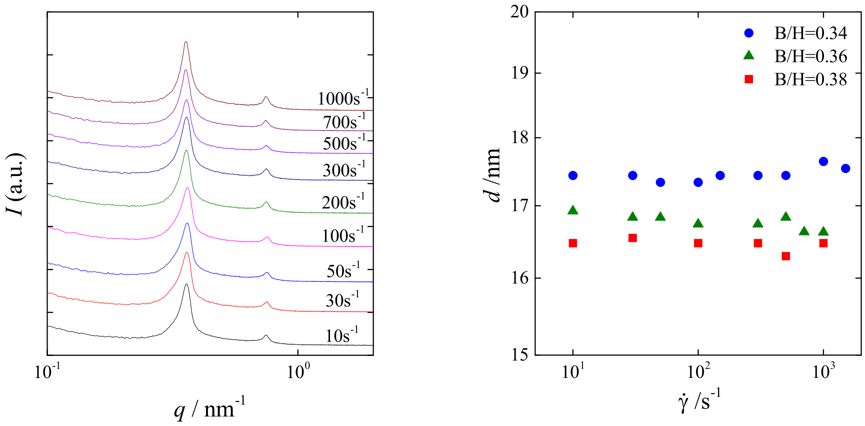

Figure 2: SAXS profiles as a function of shear rate. SAXS was measured for samples with B/H=0.34 at T=25°C. Each profiles are vertically shifted for the eyes. Lamellar spacing d at different B/H ratio are also shown together in the right panel.

3 2D-SAXS profiles for the sample with B/H=0.30 at T=21°C

Finally we show the SAXS patterns observed for the system with B/H=0.30 at T=21°C. At this condition, the system shows only the orientation transition at $\dot{\gamma}$=50s^{-1}. In the main text, we argued about the presence the steady intermediate structure on the basis of the SAXS profiles. We could detect the same SAXS patterns at different experiment conditions. Fig. 3 shows the SAXS patterns obtained around the critical shear rate. At $\dot{\gamma}$=50s^{-1}, we can see the isotropic Bragg ring in the tangential configuration while the sharp Bragg peaks can be seen in the radial one. As the shear rate is increased further, the isotropic Bragg ring gradually changes to the anisotropic peaks indicating a shift to the perpendicular orientation. As one can see the isotropic Bragg ring at $\dot{\gamma}$=50 and 70s^{-1}, the steady intermediate structure seems to present in narrow shear rate domain.

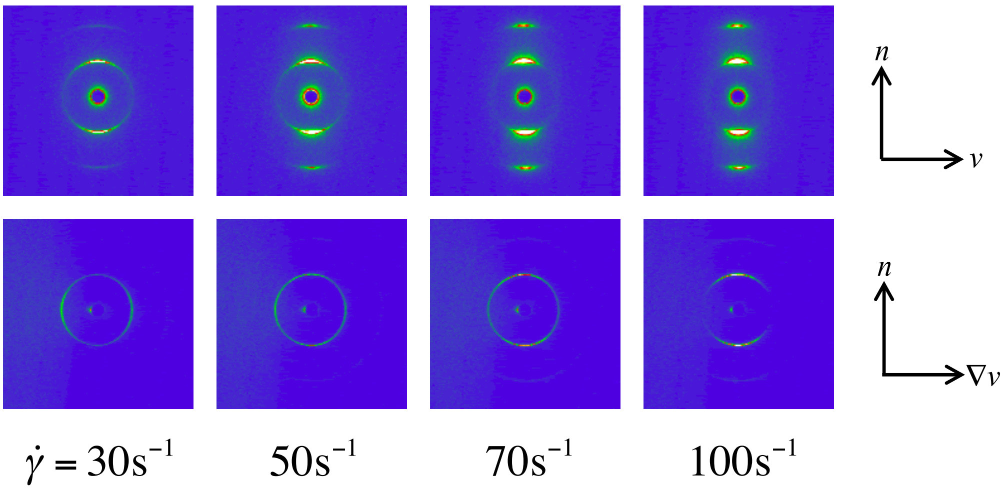

Figure 3: Rheo-SAXS patterns in the flow (v)-neutral (n) plane (radial configuration) and the neutral (n)-velocity gradient (∇v) plane (tangential configuration) are shown in the upper and bottom low, respectively. Corresponding shear rate to each images are shown on the bottom of images.

References

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[3] T. Kato, K. Minewaki, Y. Kawabata, M. Imai, Y. Takahashi, *Langmuir*, **20**, 3504-3508, (2004)