CHAOS-INDUCED MULTI-SCALE STRUCTURE DEVELOPMENT IN POLYMERIC SYSTEMS

This research utilizes set fimilar microstructures of chaotic mixing to obtain unusual morphological forms in the blending of miscible and immiscible polymers and polymers with micro- and nanoscopic fillers. roduced by application of piecewise shear flows Nevertheless, the overathixing progresses exponential rates, reminiscent of unbounded extensional flows. The epeated stretching and folginof material interfaces and alignment of material interfaces along the direction of local stretching are responsib a69c 0.141f uJi1l2-.p unbot in themixed materials Many of these

mixinghaghlighted by our work are listed

nto high aspect ratio (>1,00@)bfijbcihaotic

nensional stability of the blend materials and

e percolation. For petera a cin Figure 1 breakdown by capillary instability upon further mixing and produce much smaller droplets compared to those found in conventional mixers and much smaller than those permitted by the equilibrium between farctial and viscous forces. An analysis of flow kinematics in the chaotic mixer revealed negligible extensional flow component. Thus one would expect poor droptet formation for polymer systems with viscosity ratio greater than ~4. However, our experimes on immiscible polymers with viscosity ratio varying between 1 and 30 show that droplet formation is possible at viscosity ratios higher than 10 due to a different pathway of breakup lamella to fibrils to droplets This is different from the well studied droplet to bris to droplets pathway for breakup as in emulsions



Figure 1. Fibrillar morphology of PP-phase created by chaotic mixing of 10 wt% PP in PA6.

Publications:

- 1. Dharaiya, D., Jana, S.C., 2005 Nanocitadjuced morphology development in chaotic mixing of immiscible polymers. J. Polym. Sci., Part B: Physits (24), 36383651.
- 2. Perilla, J., Jana, S.C., 2005 Coalescence of immiscible polymer blends in chaotic mixers. AIChE J, 51(10) 26752685.
- 3. Perilla, J., Jana, S.C., 2004 A tirseale approach for analysis coalescence in polymer processing flows. Polym. Eng. Sci., 44(12), 22265.
- 4. Jana, S.C., Sau, M. 2004 Effects of viscosity ratio and composition on development of morphology in chaotic mixing of polymers. Polymet5(5), 16651678.
- 5. Sau, M., Jana, S.C. 2004 Effect of waveforms on morphology development in chaotic mixing of polymers. AIChE J50(10), 23462358.
- Sau, M., Jana, S.C. 2004 A study on the effects of chaotic mixer design and operating conditions on morphology development in immiscible polysystems. Polym. Eng. Sci., 44(3), 407422.
 Errata "A study on the effects of chaotic mixer design and operating conditions on

morphology development in immiscible polymer systems". Polym. Eng. Sci., 44(7), 1403.

- 7. Sau, M., Jana, S.C. 2003 A study on **tffeces** of chaotic mixer design and operating conditions on the development of morphology in immiscible polymer systems. SPE ANTEC, 61, 15561560.
- 8. Sau, M., Jana, S.C. 2003 Morphology development in PA6/PP system by chaotic mixing: effect of viscosity rationand composition. SPE ANTEC, 61, 150812.
- 9. Sau, M., Jana, S.C., 2002 Blending of immiscible polymer systems by chaotic mixing. ANTEC 2002 Proceeding 60, 14311435.

- 10. Jana, S.C. 2002 Avenues of introducing chaotic mixing in singlew extruders. ANTEC 2002 Proceedings60, 14361440.
- 11. Sau, M., Jana, S.C. 2002 Morphology development in immiscible polymer systems by baker's cutANTEC 2002 Proceeding 60, 14461450.

(3) We found that droplets are stable against coalescente flow field of chaotic mixersThe chaotic trajectories of droplets deter coalescence due to frequent reorientation of the shear direction. Thus finer droplet morphologies generated by chaotic mixing are further stabilized against coarsening and coalescence due to the chaotic drags of the droplets. This attributes can be