FILTRATION OF NANOCLAY CLUSTERS DURING RESIN TRANSFER MOLDING OF CLAY/GLASS/EPOXY DISKS

L. Aktas*, S. Dharmavaram*, Y. K. Hamidi*, and M. C. Altan*
Composites Research Group
School of Aerospace and Mechanical Engineering University of Oklahoma
Norman, Oklahoma 73019
altan@ou.edu

ABSTRACT

Inclusion of nanoclay in various polymer systems is being studied as a viable improvement method for thermo-mechanical properties for more than a decade. It has also been shown that addition of nanoclay into polymers significantly enhances thermal durability of the part. It is possible that the addition of nanoclay to conventional fiber- reinforced composites would provide enhanced mechanical and thermal performance. However, the interaction of nano-scale clay platelets and somewhat larger clay clusters with micro-scale fibers might lead to non-uniform clay content throughout a molded composite part.

In this study we investigate the dispersion of nanoclay in resin transfer molded clay/glass/epoxy disks. For this purpose 4 composite disks are fabricated by resin transfer molding. In addition to 14% glass fiber reinforcement, disks contained either 0, 2, 5 or 10wt.% Cloisite® 25A nanoclay. The spatial distribution of nanoclay clusters in the radial axis of the nanocomposite disks are characterized at two length scales. Clusters larger than 1.5μm are characterized by performing image analysis on the SEM micrographs obtained at 50X, whereas smaller nanoclay clusters are identified by wavelength dispersive spectrometry. In addition, to characterize the interaction of nanoclay with the polymer at the molecular level, glass transition temperature of each disk is measured under oscillatory shear.

Results obtained from image analysis indicate that as much as 50% of the nanoclay clusters are filtered out in the flow direction by the glass fiber preform. In addition, higher filtration with increasing nanoclay content suggests that clustering is more effective at higher nanoclay loadings. As a result of filtration and possible cluster breakdown, the contribution of small clusters (i.e., $Area<40\mu m^2$) to the overall cluster content is found to be as much as 22% higher than the contribution of large clusters (i.e., $Area>120\mu m^2$) at the outer edges of the disks. Glass transition temperature is observed to increase with increasing nanoclay content, suggesting that the gallery spacing of the nanoclay structures are intercalated by the epoxy resin.

*Member, ASME

References

1. Yasmin, A.; Abot, J. L.; Daniel, I. M. Mater. Res. Soc. Symp. Proc. 2003, 740,75-80.
2. Abot, J. L.; Yasmin, A.; and Daniel, I. M.; *Mater. Res. Soc. Symp. Proc.* 2003, *740*, 162-177.
3. Aktas L., Dharmavaram. S., Hamidi. Y. K. and Altan. M. C. Quantitative Analyses of Nanoclay Dispersion in Molded Epoxy Disks: Effects of Mixing Temperature. In: Nanomaterials: New Research. Nova Science Publishers. New York. pp. 197-218. 2005
4. Shen, L.; Phang, I. Y.; Chen, L.; Liu, T.; Zeng, K. *Polymer* 2004, *45*, 3341-3349.
5. Aktas L., Hamidi Y. K. and Altan M. C. Plastics. Rubber and Composites: Macromolecular Engineering. 33(6): 267-272. 2004
6. Lan, T.; Pinnavaia, T. J. Chem. Mater. 1994, 6, 2216-2219.
7. Becker, O.; Varley, R. J.; Simon, G. P. J. Mater. Sci. Lett. 2003, 22, 1411-1414.
8. Kinloch, A. J.; Taylor, A. C. J. Mater. Sci. Lett. 2003, 22, 1439-1441.