368e Foaming of Ps/Clay Nanocomposites in Supercritical Carbon Dioxide

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Solid nucleating agents are added to polymers during foaming processes to decrease the cell size and increase cell concentration. Nucleating agents such as talc and carbon black when blended with polystyrene did not provide a significant improvement in foam morphology because of their poor dispersion in the polymer.[1] To improve the cell size and distribution, the nanoparticles are to be uniformly dispersed (exfoliated) in the polymer matrix. Another method is to obtain intercalated particle dispersion, where polymer chains penetrate into the interlayer region of clays to form nanocomposites without disrupting the crystallites. The effect of adding different concentrations of exfoliated and intercalated nanoclay on the nucleation and bubble growth behavior in polystyrene – carbon dioxide batch foaming systems is explored.

An exfoliated PS/MHABS nanocomposite is prepared via in-situ bulk polymerization technique in our lab.[2] The master batch containing 10% (exfoliated/intercalated) nanoclay is diluted with pure PS in the microcompounder to obtain different concentrations of nanoclay, namely 3%, 1%, 0.3%, 0.1% and 0.03%. Residence times in the microcompounder are optimally chosen so as to achieve homogenous mixing of the clay in the polymer while avoiding polymer degradation during processing. The extruded strands with a diameter of 0.3cm are then cut into smaller samples of 1.5cm length and the samples are batch-foamed with carbon dioxide as the blowing agent. Experiments are conducted at three different temperatures – 120°C, 100°C and 80°C. For each temperature, the batch foaming process is repeated for 2 sets of pressure, namely a constant pressure case at 2000 psi pressure and a constant solubility case in which the pressure for the two lower temperature cases is chosen such that the solubility of carbon dioxide in polystyrene at each temperature is equal.

The morphology of foams is studied using scanning electron microscopy (SEM). Results for both exfoliated and intercalated foams are discussed and comparisons are also made between foams with and without nanoclay added to them. A bubble growth model is developed using heterogeneous nucleation technique and is compared with the experimental data.

References

(1) Spitael, P.; Macosko, C.W.; McClurg, R.B. *Macromolecules* **2004**, 37, 6874-6882.

(2) Zeng, C.; Lee, L.J. *Macromolecules* **2001**, 34, 4098-4103.