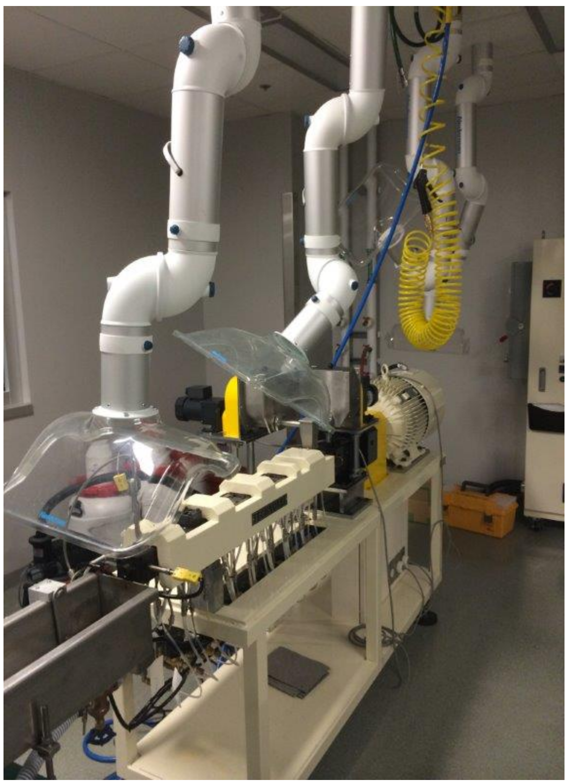
Thermoplastic Nanocomposites

Polymer nanocomposites are composed of a nanofiller dispersed into a polymer matrix. Typical fillers include nanoclay, carbon nanotubes, nanoparticle silver, nanoalumina, etc. Nanocomposite materials exhibit unique material properties, such as improved barrier properties, flame retardance, and mechanical properties, depending on the choice of filler. The materials have application for lighter weight structural parts, barrier materials for improved packaging (e.g MREs), EMI shielding, and antimicrobial performance.

One of the barriers to obtaining optimal properties is the need for excellent dispersion and distribution of the nanofiller coupled with quantitative dispersion measurement techniques. To create the materials in an industrially relevant manner, continuous melt mixing processes are necessary. We have expertise in twin screw mixing of numerous nanofillers in a wide range of thermoplastics



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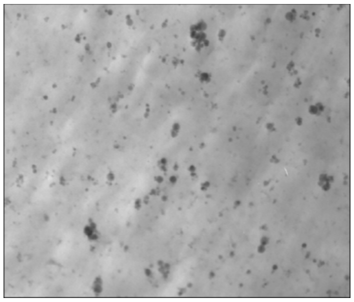
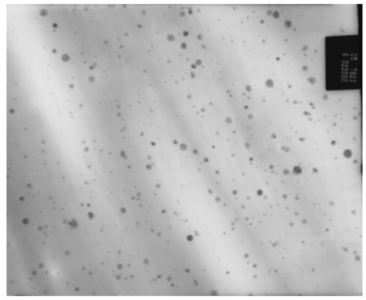
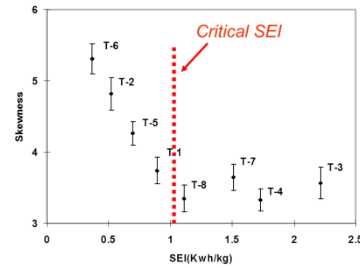


Batch Mixing



Twin Screw Extrusion



Critical energy needed for mixing of nano composites

Dispersion is dependent on processing parameters, as well as functionalization of the filler to enhance compatibility with the polymer. During processing it is critical to provide sufficient energy input to the mixture to break up the agglomerated filler. Energy input can be controlled by melt viscosity, temperature, screw speed, etc. The quadrat method has been adapted to quantify the dispersion and distribution of nanocomposites.

Publication List:

- Kim et. al. Micro Research and Tech, 70, 539-546 (2007)
- Kim et al., J. Appl. Polym. Sci., 109, 2524 (2008)
- Kim et al., Polym. Eng. Sci., 47, 2049 (2007)
- Kang et al., Macromol. Mater. Eng., 292 329 (2007)

In addition to processing, we are conducting comprehensive physicochemical, morphological, and toxicological characterization of emissions and personal exposures to nanoparticles, carbon nanotubes and respirable fibers during several critical steps in the lifecycle of these composites: synthesis, recycling, post-processing (cutting, drilling, and weatherization) and end-of-life disposal, for different types of composites. The impact of recycling, process conditions, composite type, and other relevant properties on several exposure metrics is also being studied. An important feature of these studies is the use of integrated approaches that link comprehensive exposure characterization with the latest in vitro and in vivo dosimetry modeling and nano toxicity testing.

Publications

Khatri et al Particle Fiber Tox. *10:42 (2013)*

Khatri et al Inhal Tox *25:11, 621-632* (2013)

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Bello et al Nanotoxicology 7(5):989-1003 (2013)

Bello et al *Int J Occup Env Health*, 16 (4): 434-450 (2010)

Bello et al J Nanoparticle Res 11(1): 231 (2009)

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