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Characterizatin of Nanoclay Dispersion in Epoxy Matrix by Combined Image Analysis and Wavelength Dispersive Spectrometry

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Dispersion of different nanoclay types in epoxy matrix is investigated at two different length scales by the combination of digital image analysis and wavelength dispersive spectroscopy. Initially,Cloisite®15A, 25A and 30B are individually mixed with Epon 815C epoxy resin, by the aid of a sonicator. The resin/nanoclay compound is then mixed with curing agent and injected into a center-gated disk shaped mold. The dispersion of nanoclay is characterized using samples cut along the radius of the nanocomposite disks. Nanoclay clusters larger than 1.5μm are characterized by performing digital image analysis on the scanning electron micrographs, whereas smaller clusters are identified by wavelength dispersive spectrometry (WDS). In addition, a qualitative evaluation of the microstructure is made based on transmission electron microscopy. It is found that the effectiveness of dispersion increases in the order of Cloisite®15A, 25A and 30B. For instance the average content of clusters larger than 1.5μm is determined as 4.6vol.% for Cloisite®15A, whereas the same value for 25A and 30B are 3.39vol.% and 3.45vol.%, respectively. The nanoclay clusters are observed to break down into smaller pieces in the flow direction, regardless of the nanoclay type. For example, small Cloisite®30B clusters (Area<3μm^2) make up 37.8% of the nanoclay content at the inlet, whereas the same value is calculated to be 46% at the outer edge of the disk. Cluster breakdown also caused nanoclay clusters to assume more irregular shapes at the outer edge of the disks. Transmission electron micrographs indicated existence of nano-scale voids trapped within the clusters. In addition, as evidenced by domains of different transparencies in the vicinity of clusters, curing is believed to be affected by the existence of nanoclay.