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SIMPLE APPROACH TO CHARACTERIZE THE DISPERSION STATE OF MULTIWALLED CARBON NANOTUBES IN AN EPOXY MATRIX FROM RHEOLOGY AND ELECTRICAL CONDUCTIVITY MEASUREMENTS

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Monitoring the quality of dispersion within a polymer suspension is a fundamental problem since the enhancements of thermal, electrical and mechanical properties are depending on it. A direct consequence of the incorporation of carbon nanotubes (NTCs) in a polymer suspension is the significant change in the viscoelastic and electrical properties. In this work, we report on rheological properties and electrical conductivity measurements performed on a suspension made with multiwalled carbon nanotubes in a masterbatch (25 % wt) from Arkema to be diluted with an epoxy prepolymer DGEBA (Diglycidyl ether of bisphenol A, LY556, Huntsman) to reach the right concentration of nanotubes varying from 0 to 2 % wt. Particular attention is paid to the mixing of nanotubes by varying macroscopic shearing by using different mechanical tools (rotary blade, 3 Roll Mill…), local shearing by varying NTC concentration, in different mixing conditions (mixing temperature, mixing time or mixing intensity). We showed that the rheological signature is very sensitive to the state of dispersion of the nanotubes (individually dispersed, aggregates, percolating structures). Indeed one of the essential events is the formation by nanotubes of a network which can occur for a very small amount of nanotubes (less than 1% wt) if they are well dispersed. This network is characterized by a decrease of the slope of G' at low frequency and the appearance of a plateau for this storage modulus characteristic of a significant elastic answer. It is known that carbon nanotubes are very good materials to conduct the electricity. So it is possible to increase the conductivity by several orders of magnitude for a composite reinforced with carbon nanotubes just if the electrical percolation threshold is reached. In this work, the electrical conductivity is followed in the same time that the rhéological analysis during the curing of the network. The percolation threshold will be determined from a combination of both analysis as a function of the mixing conditions and NTCs ratios. Better the dispersion state is, higher the electrical conductivity will be because of the building up of an efficient nanotube network that promotes the electrical conductivity in the nanocomposites.