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Quantitative Processing-morphology Relationships in Carbon Nanofibre/Polypropylene Composites Production

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Due to the small diameter of Carbon Nanofibres (CNFs) in combination with significant fibre lengths (diameters and lengths of circa 90 nanometers and 500 micrometers, respectively), their thermoplastic composites can offer permanent conductivity at ESD-levels or below, at very low filler levels, thus not affecting the processing and other beneficial of the host polymer. This makes these materials of particular interest for e.g. electrostatically painted automotive parts. However, ultimate composite properties depend largely on the morphology (CNF distribution/dispersion quality) of the material, which on its term is directly related to the processing history of the material. Quantifying (rather than qualifying) the morphology in these material is therefore critical in establishing direct relationships between processing and final material properties, which can subsequently be used to tailor composite properties for desired application levels. The present work studies polypropylene composites reinforced with CNFs (Applied Sciences' Pyrograph III) produced by melt extrusion. A wide range of processing conditions is used, to cover as much as possible the complete spectrum of processing history of the various composite produced. A modelling code is used to predict the various levels of shear induced during processing. The morphology of the produced composites is subsequently characterised using transmitted light optical microscopy by means of grey scale analysis. The quantitative description thus obtained is compared to the processing history as obtained by the simulations. The results show a clear relationship between processing history and the resulting level of CNF- dispersion/distribution in the composites.