Accepted Manuscript

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PII: S0266-3538(18)31571-9

DOI: 10.1016/j.compscitech.2018.09.015

Reference: CSTE 7397

To appear in: *Composites Science and Technology*

Received Date: 2 July 2018

Revised Date: 12 September 2018

Accepted Date: 15 September 2018

Please cite this article as: Marcourt M, Cassagnau P, Fulchiron René, Rousseaux D, Lhost O, Karam S, A model for the electrical conductivity variation of molten polymer filled with carbon nanotubes under extensional deformation, *Composites Science and Technology* (2018), doi: https://doi.org/10.1016/j.compscitech.2018.09.015.

A model for the electrical conductivity variation of molten polymer filled with carbon nanotubes under extensional deformation

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Abstract:

This work is dedicated to analyzing the variation of conductivity of polymer composites (polystyrene filled with Carbon Nanotubes) under extensional deformation. In a previous work, a conductor-insulator transition has been observed and the predominant role of the polymer dynamics has been brought to light. The evolution of the filler network within a polymer matrix can be described by a kinetic equation that takes into account a structuring mechanism that is controlled by the mobility in the melt matrix and a destruction mechanism that is induced by the extensional deformation. The solution of this equation that describes the filler network at a microscale is used in the percolation law to obtain the macroscopic conductivity of the composite. It turned out that the structuring parameter does not depend on the extensional deformation but only relies on the polymer matrix dynamics. In addition, the breaking parameter only depends on the Hencky strain, whatever the extensional rate. This model has been successfully applied for a large range of filler concentrations and experimental conditions from low to large Weissenberg numbers.

Keywords: Nanocomposites; Carbon Nanotubes, Extensional Viscoelasticity; Electrical conductivity; Modeling.