INFLUENCE OF THERMO-RHEOLOGICAL HISTORY ON CARBON NANOTUBE COMPOSITE MELTS: COMBINED RHEO-ELECTRICAL EXPERIMENTS

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ABSTRACT

Although, carbon nanotube (CNT)-polymer composites are meanwhile commercially available a major restraint in broad market acceptance is the wide variation of electrical conductivity and partially of the mechanical properties on the processing conditions. The tremendous influence of processing conditions on the electrical conductivity has been demonstrated by in-line measurements during extrusion[1,2] and mould injection[3].

In order to achieve a deeper understanding of the influence of thermo-rheological history on electrical and mechanical properties systematic rheo-electrical laboratory experiments have been performed on the CNT-composite melts[4-6]. In those experiments the electrical conductivity and the complex shear modulus (G', G'') were measured simultaneously during or after well defined shear deformations of the melt: (i) transient shear, (ii) recovery after shear in the quiescent melt and (iii) quasi-steady shear.

The time-evolution of shear modulus, viscosity and conductivity were found to depend strongly on the rheological and thermal history. For instance, under steady-shear conditions conductivity and modulus were found to depend strongly on the initial state of CNT agglomeration and the applied shear rate. Both shear induced destruction and formation of the filler network was detected. Under steady flow the electrical and mechanical properties approach stationary values, representing a "dynamic equilibrium" of the filler network[6]. Furthermore, is has been shown that the mechanisms for charge carrier transport and viscoelasticity of the filler network are different[6].

The findings were described by a model combining the interplay of destruction and reformation of the filler network under shear[5,6]. The model has been applied for FEM simulation of mould injection.

References

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