COMBINED DIELECTRIC AND RHEOLOGICAL INVESTIGATIONS ON POLYMER NANOCOMPOSITES

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We investigate the viscoelastic behavior of polymer nanocomposites under different kind of flow. For this we mixed NR (SVR) with carbon black and carbon nanotubes (CNTs), respectively. Our method for investigation is a combined dielectric and rheological spectroscopy. We are using a modified commercially available rotational rheometer from Anton Paar, Model MCR 501. The engine in this rheometer is tuned to deliver enough torque to squeeze high-viscous polymers, like rubber melts. The cell and the upper plate are modified to connect a high-resolution dielectric analyzer from Novocontrol.

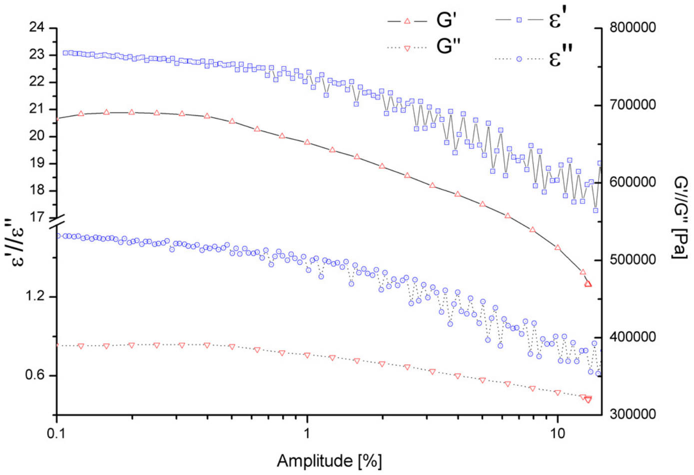
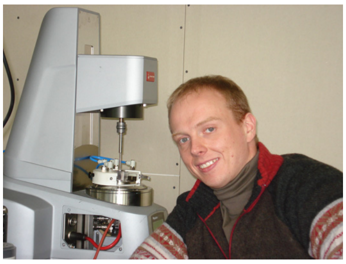


FIG 1 Combined strain sweep measurements of G* and ε^* of a carbon black filled rubber melt.

We first look at the rubber-nanotubes-composite under steady state and oscillatory shear flow. We analyze the dielectrical behavior of this nanocomposite online while measuring the rheological data. These measurements give us a deeper insight into the nature of flocculation (aggregation) of filler particles. Earlier measurements of carbon black-filled rubber melts in steady flow, measured in a high-pressure-capillary-rheometer equipped with a modified dielectric-slit capillary, already showed interesting results. We expect to observe the filler network breakdown under steady- and harmonic shear, respectively, and further information about relaxations of the nanocomposite. Figure 1 shows a mechanical amplitude sweep of a rubber melt filled with 50-phr carbon black. The mechanical frequency was 10 Hz and the amplitude reached approximately 10% (this was reduced to the maximum torque delivered by the machine). The frequency of the online-dielectric analyzer was fixed to 1 kHz. It can be seen that the dielectric function decreases with the amplitude build up, an occurrence attributed to the Payne effect. A further aim is to find correlations with the dispersion degree of the nanoparticles and the coupled dielectric-rheological data. For this we will compare our measurements with microscopic and scattering methods like AFM, x-ray-computer tomography, light microscopy and x-ray-scattering-rheology. The last one is at moment in the final phase of development at the Free-Electron-Laser department within the DASY research institute in Hamburg.

After we optimized the settings for our combined dielectric and rheological measurement device we also want to have a deeper insight of the influence of the nanotubes on the normal stress coefficients. Our rheometer is equipped also with several kinds of cone-geometries. For this future investigation, we plan to use low molecular weight rubber compounded with CNTs to measure effects in the cone-plate geometry.



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- Untersuchung des elastisch-turbulenten Flusses in Polymerlösungen und -schmelzen
- Untersuchung von leitfähigen Nanokompositen mittels kombinierter dielektrischer und rheologische Analyse