Einladung zum Vortrag

Thermo-viscoelastic and viscoplastic behavior of carbon black-reinforced thermoplastic elastomers

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Abstract

This study is concerned with the experimental analysis and constitutive modeling of the effect of temperature on the viscoelastic (relaxation tests) and viscoplastic (cyclic tensile tests) responses of thermoplastic elastomers reinforced with carbon black particles. From the standpoint of applications, the interest to this subject is driven by a search for a sealing material (that demonstrates excellent mechanical properties coupled with strong chemical and thermal resistance) for low-temperature and medium-temperature proton exchange membrane fuel cells. From the point of view of fundamental research, an advantage of polymer composites with thermoplastic-elastomer matrices (compared with conventional vulcanized rubbers) is that (i) their response can be experimentally investigated in a wide range of temperatures (from ambient temperature up to 200°C), and (ii) no pre-loading is required to ensure high repeatability of observations, which implies that the Mullins and Payne effects may be examined in detail.

The experimental study focuses on the mechanical response of commercially available polymer composites Thermoplast K (a hydrogenated styrene block copolymer with addition of polypropylene segments) and Tecnoflon P (a high fluorine terpolymer of vinylidene fluoride, hexafluoropropylene, and tetrafluoroethylene).

Constitutive equations are derived for the viscoelastic and viscoplastic responses of a thermoplastic elastomer at three-dimensional deformations with finite strains. Given a temperature and strain rate, the stress-strain relations for cyclic deformation involve 6 to 7 adjustable parameters that are found by fitting the experimental data. It is shown that the governing equations correctly describe the observations and the material parameters are affected by temperature and strain rate in a physically plausible way.

The constitutive model is applied to predict the mechanical response of the polymer composites in low cycle fatigue tests and cyclic shear tests. An acceptable agreement is shown between the experimental data and the results of numerical simulation.