JOINING PHYSICAL MODELING AND ADVANCED TESTING OF DYNAMIC-MECHANICAL PROPERTIES OF RUBBER NANOCOMPOSITES

Prof Gert Heinrich

Leibniz-Institut für Polymerforschung Dresden e.V., Technische Universität Dresden,
Dresden D-01069 Germany, E-mail: gheinrich@ipfdd.de

ABSTRACT

The presentation starts with a brief description of the present state of multiscale modeling of quasi-static properties of filled elastomers following the rigorous physically based route from (non-Gibbsian) statistical mechanics of crosslinked and entangled networks to continuum mechanics and FE-mechanics. We show how this persued route and the corresponding models behind (extented tube-model of rubber elasticity) could be confirmed by several physical experiments (e.g. neutron scattering) and by the excellent performance of the derived material laws for several engineering applications.

The extraordinary challenges to realize a similar approach and sustained route for the dynamic-mechanical properties of filled rubber materials are discussed in the main part of the presentation. We describe the present state of art, problems, efforts and new results concerning:

- Formulation of a non-equilibrium statistical mechanics of rubber networks starting from a suitable Rayleigh's dissipative function of network dynamics;
- Application of physical models with their intrinsic characteristic relaxation times for different frequency regimes in the viscoelastic mastercurves of elastomers;
- Application of advanced tesing and data evaluation procedures to establish mastercurves of the non-linear viscoelastic behaviour of filled rubber nanocomposites;

The comparision between profound physical modeling and experimental characterization is exemplified on silica filled styrene-butadiene copolymers (S-SBR) that find applications as tire tread compounds.

References:

Vilgis, T. A. ; Heinrich, G. ; Klüppel, M. : Reinforcement of Polymer Nano-Composites : Theory, Experiments and Applications. Cambridge University Press, 2009. - 222 pages

Stöckelhuber, K.W.; Svistkov, A.; Pelevin, A.; Heinrich, G.. Impact of filler surface modification on large scale mechanics of styrene butadiene/silica rubber composites Macromolecules 44 (2011) 4366-4381