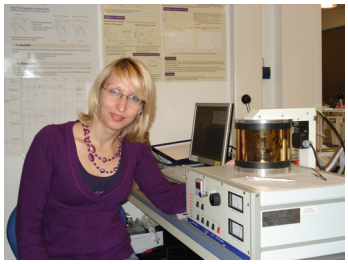
DIELECTRIC STUDY OF NANOSCALIC SILICA AND SILICA FILLED STYROL-BUTADIENE-RUBBER

J. Fritzsche, M. Klüppel, R.H. Schuster

Deutsches Institut für Kautschuktechnologie e.V., D-Eupener Straße 33, 30519 Hannover
juliane.fritzsche@dikautschuk.de, manfred.klueppel@dikautschuk.de

The reinforcement of elastomers by activated silica fillers plays an important role in the improvement of the dynamical and mechanical properties especially in the tire industry. In example, wet traction properties and the rolling resistance could be improved significantly by the incorporation of precipitated silica delivering the so called green tires . This new generation of high performance tires could only become a successful technology after the dispersion problem was solved by coating the silica with a bifunctional silane in a complicated multi-step procedure, which allowed an effective dispersion of the nano-particles as well as a chemical coupling of the polymer chains to the silica surface.
Even with numerous studies focusing on the polymer-filler coupling the reinforcement mechanism of the silica filled rubbers has not yet been clarified satisfactory. This is in contrast to carbon black filled rubbers where it has been ascribed to strong physical adsorption of polymer chains onto the carbon black surface often attributed as bound rubber. Due to the direct chemical coupling between silica and polymer using an coupling agent the mechanism should be different for silica filled samples.
The hydrophilicity of silica is very high and there is always some water adsorbed on the surface of the silica, which competes with the adsorption of the polymer chains , . Several authors 2, 3, , , 6 reported the identification of water by dielectric relaxation spectroscopy on the surface of pure silica as well as on the silica surface in polymer composites. But up to know the influence of water on the polymer filler interaction as well as the interaction with the used coupling agents is not well investigated especially in praxis relevant composites.
In this work, we will focus on the change of the relaxation dynamics of adsorbed water at the silica surface. Different silica types with varying morphology are investigated by dielectric spectroscopy. We will compare the dielectric spectra of the pure precipitated silica with modified silica using a coupling agent. Additionally, high performance elastomer composites were prepared consisting of solution styrene-butadiene rubber (S-SBR) and precipitated silica. We will show that there is an adlayer of water on the silica surface in the presence of polymer with and without silane resulting in a dielectric low temperature response. The relation to the amount of water was proven by measuring the silica before and after heating. The relaxation dynamics of the water are significantly influenced by the use of an coupling agent. Additionally the interaction of the silica surface with the polymer chains changes the relaxation dynamics extensively.

[1] Wolff, S. In Silica based tread compounds - background and performance, Tire Tech '93,Basel, Switzerland, 1993.
[2] Fragiadakis, D.; Pissis, P.; Bokobza, L., Polymer 2005, 46, (16), 6001-6008.
[3] Kirst, K. U.; Kremer, F.; Litvinov, V. M., Macromolecules 1993, 26, (5), 975-980.
[4] Spanoudaki, A.; Albela, B.; Bonneviot, L.; Peyrard, M., Eur. Phys. J. E 2005, 17, (1), 21-27.
[5] Cerveny A., Colmenero J., Alegria A., Eur.Phys. J. Special Topics, 2007, 141, 49-52
[6] Meier, J. G., Fritzsche, J., Guy, L., Bomal, Y., Klüppel, M., Macromolecules, 2009, accepted



Dipl.-Chem. Juliane Fritzsche (MM)
am DIK seit 07/2006

- Dielektrische und dynamisch-mechanische Spektroskopie
- Ermüdungsverhalten von Elastomeren
- Herstellung und Charakterisierung von Nanomaterialien auf Basis von CNT und Schichtsilikaten
- Ladungstransport in Ruß- und CNT-Netzwerken