

CPP 10: Polymer Physics I

Time: Monday 18:00–19:30

Location: ZEU 114

CPP 10.1 Mon 18:00 ZEU 114

Fabrication of Metallic/Bimetallic Microtubes using Self-rolled Polymer Tubes as Templates — ●KAMLESH KUMAR¹, BHANU NANDAN¹, VALERIY LUCHNIKOV², BHOJE GOWD¹, and MANFRED STAMM¹ — ¹Leibniz Institute of Polymer Research Dresden, Hohe Strasse 6, 01069 Dresden, Germany — ²Institute de Chimie des Surfaces et Interfaces, rue Jean Starcky 15, 68057 Mulhouse, France.

We present a new approach to fabricate single and bimetallic (Au, Ti, and Au/Ti) microtubes with high aspect ratio using self-rolled polymer tubes as templates. This approach is based on the phenomenon of the stress relaxation of thin multi-layer films via curling. We explore self-rolling of a cross-linked polymer film, capped by metallic or bimetallic layer, in an organic solvent. In a typical fabrication scheme, the multilayer consists of the bottom poly(4-vinylpyridine) (P4VP) film, the intermediate polystyrene (PS) film, and the top metallic or bimetallic film is used. The internal stress and the bending moment are induced in the film due to swelling of the bottom P4VP layer after dipping the sample into aqueous solution of dodecylbenzenesulfonic acid (DBSA). The length of the tubes and the direction of rolling are determined by mechanical patterning of the film, whereas the tube diameter is tailored by varying the thickness of the polymer and metallic layers. After rolling, polymer template is removed by pyrolysis resulting in pure metal microtubes. Metallic microtubes fabricated by self-rolling approach may find applications in such fields as IR-waveguiding, microfluidics, enzyme bi-reaction, chemical and biochemical sensing.

CPP 10.2 Mon 18:15 ZEU 114

Molecular acoustic studies around the boundary between network-forming reactive liquids — ●ROLAND SANCTUARY, MARTINE PHILIPP, JÖRG BALLER, BARTOSZ ZIELINSKI, ULRICH MÜLLER, and JAN KRISTIAN KRÜGER — Université du Luxembourg, Laboratory of Physics of Condensed Matter and Advanced Materials (LPM), 162a, avenue de la Faïencerie, L-1511 Luxembourg

Scanning Brillouin microscopy is used to investigate chemical reactions and molecular transport processes around the interface between the layered reactive constituents of epoxies. The temporal evolution of the spatial hypersonic landscape behaves significantly asymmetric along the resin and hardener rich region and is attributed to a complicated superposition of polymerization, transport, dissolution and molecular disintegration phenomena. The temporal and spatial distributions of the sound velocity in the hardener and resin rich zones of the samples seem to show chaotic behavior. If in addition alumina nanoparticles are initially present in the resin, interfacial polymerization changes its character in comparison to the system involving the pure resin. According to the hypersonic behavior the penetration of the hardener in the filled resin seems to be hindered by the presence of the nanoparticles. In turn, once the alumina nanoparticles have entered the hardener rich region, they seem to develop a catalytic influence on the epoxy polymerization.

CPP 10.3 Mon 18:30 ZEU 114

Particle-Related Microstructural Investigations of Polymer-Nanoparticle Composites using Scanning Electron Microscopy (SEM) and Stereology — ●MARKUS ZIEHMER, ULRICH MÜLLER, JÖRG BALLER, and ROLAND SANCTUARY — University of Luxembourg, Physics of Condensed Matter and Advanced Materials, 162a, Avenue de la Faïencerie, L-1511 Luxembourg

Epoxy polymers containing nanoparticle fillers represent just one of the manifold possibilities of constructing nanocomposite systems which have achieved great scientific and technical interest during the last decade. A lot of work has been done in order to understand the macroscopic physical properties of such functional materials. At a certain step, knowledge about the particle-related microstructure is indispensable. Thus, suitable microscopic techniques are necessary. Usually, solely Transmission Electron Microscopy (TEM) and Atomic Force Microscopy (AFM) are performed, although both methods show some well-known intrinsic shortcomings. Modern SEM has the means to overcome these problems and can fill the information gap between TEM and AFM measurements, even for difficult materials like polymer-nanoparticle mixtures. Low-voltage SEM provides the opportunity to sample rather thin surface layers. The particles can easily be identified. Established stereological methods can be used to cal-

culate more reliable interparticle distances and to look at the spatial particle distributions. We report about first experiments and results performed on DGEBA/DETA systems filled with different contents of alumina and silica nanoparticles.

CPP 10.4 Mon 18:45 ZEU 114

Curing of epoxy-based nanocomposites: Influence of the nanoparticles and their surface coating — ●JÖRG BALLER, MARKUS ZIEHMER, MATTHIEU THOMASSEY, BARTOSZ ZIELINSKI, MARTINE PHILIPP, ULRICH MÜLLER, JAN KRISTIAN KRÜGER, and ROLAND SANCTUARY — Université du Luxembourg, Laboratory of Physics of Condensed Matter and Advanced Materials (LPM), 162a, avenue de la Faïencerie, L-1511 Luxembourg

Interaction between inorganic filler particles and polymer matrix in epoxy-based nanocomposites mainly takes place at the giant surface of the nanoparticles. Often these surfaces are coated with a hydrophobic layer e.g. to avoid aggregation of nanoparticles. This coating can dominate the interaction between polymer matrix and dispersed nanoparticles. There are quite a lot of possible interactions imaginable. They range from chemical interactions like catalysis of the epoxy curing by the nanoparticles to physical interactions which may e. g. influence the thermodynamic miscibility of different components constituting the epoxy network. Comparing nanocomposites with coated silica and uncoated alumina particles delivers insight into the manifoldness of possible interactions. Thermal, rheological and spectroscopic methods are used to determine the evolution of physical properties before, during and after cure of epoxy nanocomposites.

CPP 10.5 Mon 19:00 ZEU 114

Shelf Life of one-component epoxy resin system studied by Positron Annihilation Lifetime Spectroscopy — ●M. Q. SHAIKH¹, K. RAETZKE¹, F. FAUPEL¹, and P.-L. M. NOESKE² — ¹Institute for Materials Science, Chair for Multi-component Materials, Faculty of Engineering, Christian-Albrecht-University of Kiel, 24118 Kiel, Germany — ²Fraunhofer IFAM, 28349 Bremen, Germany.

One-component epoxy formulations consist of epoxy resin, hardener, filler and the accelerator. They are preferred for industrial applications, but unlike two-component epoxy resin systems they have a limited shelf-life. Positron annihilation lifetime spectroscopy (PALS) was used to study the curing behavior of epoxy resins of DGEBA with a hardener of dicyandiamide (DICY), from the initial viscous state of the formulation to the solid state of cured polymer. Several isothermal measurements were done in the temperature range from 50°C to 80°C. PALS parameters seem to correlate very well with the curing mechanism in the samples. Gelation was observed as an increase in the intensity of ortho-positronium (*o*-Ps) and a sharp decrease in the lifetime. Change of (*o*-Ps) lifetime was used as a measure for the degree of curing. Applying the Johnson-Mehl-Avrami-Kolmogorov approach under reasonable assumptions, these experimentally observed changes could be characterized by determining the growth exponent '*n*' and reaction constant '*k*'. Thus, we were able to extrapolate the shelf life of this particular one component epoxy formulation at room temperature. Acknowledgements. This work was supported by the BMBF (03X0026F 'Nanomodule').

CPP 10.6 Mon 19:15 ZEU 114

Interfacial Polarization and Field Induced Orientation in Self Assembled Nanostructured Soft Ion Conductors — ●PETER KOHN, KLAUS SCHRÖTER, and THOMAS THURN-ALBRECHT — Institut für Physik, Martin-Luther-Universität Halle-Wittenberg

We report about the effects of interfacial polarization in and upon a self assembled nanostructured ion conductor, consisting of an ordered, lamellar block copolymer with a Lithium salt dissolved selectively in one component. Impedance spectroscopy in combination with frequency dependent orientation experiments enable a quantitative analysis of ionic polarization and a direct demonstration of its aligning effect on the interfaces. The transition time from the fast dielectric to the slow ionic interfacial polarization is much longer than expected from classical Maxwell-Wagner-Sillars theory and attributed to the formation of diffuse double layers at the internal interfaces. The much stronger orientation effect of ionic as compared to dielectric polarization offers a new route to align microdomains and therewith the ion

conducting paths of the polymer.

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