

DY 38: Glasses and Glass Transition - Part II (joint session CPP/ DY/DF)

Time: Thursday 15:00–17:30

Location: ZEU 114

Invited Talk DY 38.1 Thu 15:00 ZEU 114
Microscopic investigation of creep in glasses — TATJANA SENTJABRSKAJA¹, PINAKI CHAUDHURI², WILSON POON³, JÜRGEN HORBACH², STEFAN EGELHAAF¹, and ●MARCO LAURATI¹ — ¹Condensed Matter Physics Laboratory, Heinrich Heine University, Düsseldorf, Germany — ²Theoretische Physik II, Heinrich Heine University, Düsseldorf, Germany — ³SUPA and COSMIC, The University of Edinburgh, United Kingdom

The microscopic origin of the creep rheological response of colloidal glasses is investigated, based on the particle-level dynamics measured by confocal microscopy during application of a step stress. Subdiffusive single-particle dynamics are the microscopic signature of creep. At a more local scale enhanced dynamic activity is observed at random locations, with the number of active regions following the time-dependence of the macroscopic strain. Instead, diffusive dynamics characterise the flowing system, with a transient super-diffusive regime during the onset of flow. Transient super-diffusion coincides with the appearance of enhanced dynamics in a specific region of the system, which subsequently rapidly expands and finally spans the whole system when the steady state of flow is reached.

Invited Talk DY 38.2 Thu 15:30 ZEU 114
Getting into shape: Jamming of frictional particles. — ●MATTHIAS SCHRÖTER, JEAN-FRANÇOIS MÉTAYER, FRANK RIETZ, and MAX NEUDECKER — MPI for Dynamics and Self-Organization

In recent years the Jamming paradigm has been promoted as a grand unifying theory of particulate soft matter systems like foams, colloids, emulsions, and granular media [1,2]. However, this approach has mostly evolved from simulations of soft, perfect spheres. Real world particulate systems are often "rough" on either a microscopic or a particle scale. In the first case we talk about friction, in the second about non-spherical shapes.

This talk will use 3D imaging techniques such as X-ray tomography to provide insight into the mechanical stability of tetrahedra packings [3], the volume response of sheared granular media, and the first order phase transition occurring at Random Close Packing. We will show that in non of these three examples the underlying physics is adequately described by the Jamming paradigm.

[1] A. Liu and S. Nagel, *Ann. Rev. Cond. Mat. Phys.* **1**, 347-369 (2010)

[2] M. van Hecke, *J. Phys.: Condens. Matter* **22**, 033101 (2010)

[3] M. Neudecker, S. Ulrich, S. Herminghaus, and M. Schröter, *Phys. Rev. Lett.* **111**, 028001 (2013)

DY 38.3 Thu 16:00 ZEU 114
Glassy Dynamics of Collapsed Isolated Polymer Chains — ●MARTIN TRESS¹, EMMANUEL URANDU MAPESA¹, MANFRED REICHE², and FRIEDRICH KREMER¹ — ¹Universität Leipzig — ²MPI für Mikrostrukturphysik, Halle

While structure and conformation of condensed, isolated low molecular weight and polymeric molecules are well explored, knowledge concerning their dynamics, as measured in a broad spectral range and at widely varying temperatures is sparse. To overcome this, Broadband Dielectric Spectroscopy is combined with nano-structured electrodes having 35 nm separation and the dynamics of collapsed isolated poly(2-vinylpyridine) (P2VP) globules is measured. The collapsed globule conformation is revealed by Atomic Force Microscopy scans of the identical samples with an average globule volume corresponding to the estimate for a single chain (using the molecular weight and bulk density). Hence, for the first time the dynamic glass transition of condensed isolated polymer chains is directly measured and found to be bulk-like; only segments close (< 0.5 nm) to the substrate are weakly slowed down. The observation of bulk-like dynamics is in full accord with the length scale on which the dynamic glass transition is to be expected. In contrast, the emersion of new, slower relaxation modes is attributed to attractive interactions of the P2VP segments with the supporting silica surface, a finding which is corroborated by complementary infrared experiments. Our approach paves the way for numerous experiments on the dynamics of isolated molecules.

15 min break

DY 38.4 Thu 16:30 ZEU 114
A direct quantitative measure of surface mobility in a glassy polymer — YU CHAI¹, ●THOMAS SALEZ², JOSHUA D. MCGRAW³, MICHAEL BENZAQUEN², KARI DALNOKI-VERESS⁴, ELIE RAPHAËL², and JAMES A. FORREST¹ — ¹University of Waterloo, Canada — ²ESPCI, Paris, France — ³Saarland University, Saarbrücken, Germany — ⁴McMaster University, Hamilton, Canada

The simple geometry of a polymer film on a substrate with a step at the free surface is unfavourable due to the excess interface induced by the step, thus allowing for a new nanoprobe of the melt state rheology. After recalling the experimental technique, we demonstrate how the same theoretical tools enable to understand the surface evolution of thin polymer films below the glass transition temperature T_g . While above T_g the entire volume between the substrate and the free surface participates to the flow, below T_g only a near surface region responds to the excess interfacial energy. In the latter case, the developed thin film theory for flow limited to the free surface region is in excellent agreement with experimental data. Strikingly, the system transitions from whole film flow to surface localized flow over a narrow temperature region near the bulk glass transition temperature. The measurements and model presented provide a quantitative measure of the surface mobility in a sample geometry where the confinement of polymer chains and substrate effects are negligible. Therefore, this study may help to solve further the ongoing controversy around glass transition in polymer films.

DY 38.5 Thu 16:45 ZEU 114
Effects of soft confinement on the glass dynamics of glycerol, studied by deuteron NMR — ●MICHAEL LANNERT¹, MARKUS ROSENSTIHL¹, THOMAS BLOCHOWICZ², BERND STÜHN², and MICHAEL VOGEL¹ — ¹Institut für Festkörperphysik, Hochschulstraße 6, 64289 TU Darmstadt — ²Institut für Festkörperphysik, Hochschulstraße 8, 64289 TU Darmstadt

The dynamics of glycerol in a microemulsion with droplet diameters ranging from 2nm to 9nm were investigated by deuteron NMR in the temperature range 150K - 330K. While previous studies of liquid dynamics in confinement mostly used solid matrices, microemulsion droplets formed by AOT surfactants and toluol/m-xylol provide a soft confinement. Deuteron NMR longitudinal (T_1) and transversal (T_2) spin relaxation times, solid echo spectra, and two time correlation functions were recorded. High temperature dynamics are independent from droplet diameter and a Vogel-Fulcher-Tamann temperature dependence was observed. The line shape transition occurs at 240K for all studied droplet sizes, but is broader in confinement than in bulk, indicating a broadening of the distribution of correlation times. Time constants obtained from the measured correlation functions exhibit a weaker, Arrhenius temperature dependence. Detailed analysis suggests that the reorientation results from the rotational diffusion of whole droplets rather than individual molecules.

DY 38.6 Thu 17:00 ZEU 114
Single molecule diffusion measurements in highly viscous media — ●DOMINIK WÖLL^{1,2} and MAREN DILL² — ¹Zukunftskolleg, Universität Konstanz, D-78457 Konstanz — ²Fachbereich Chemie, Universität Konstanz, D-78457 Konstanz

Single molecule diffusion measurements in highly viscous media require a method which can readily detect very low diffusion coefficients. Single molecule fluorescence tracking typically becomes rather unreliable for diffusion coefficients below 10^{-18} m² s⁻¹ due to the limited accuracy in determining single molecule positions of a few nanometres and the need for a very high stability of the optical system, even for long-time measurements of several hours. We developed a photocleavable energy transfer dyad which, so far, has allowed us to extend the range of single molecule (pair) diffusion measurements by three orders of magnitude and to determine slow single molecule motion in polymer films in close vicinity to their glass transition temperature. As a FRET pair, we used a perylene and a terrylene diimide derivative, two very efficient and stable fluorophores ideal for single molecule fluorescence spectroscopy. A phenacyl derivative was chosen as the photolabile moiety which could be cleaved with UV light. Initially, the two fluorophores are covalently bound to each other and move correlated before they are cleaved by a UV light pulse and their diffusive

separation gives access to low diffusion coefficients of down to 10^{-21} $\text{m}^2 \text{s}^{-1}$ and beyond.

DY 38.7 Thu 17:15 ZEU 114

Intermittent Quakes on Surface of Soft Glassy Suspensions

— •TADASHI KAJIYA¹, TETSU HARU NARITA², VELONIQUE SCHMITT³, FRANCOIS LEQUEUX², and LAURENCE TALINI² — ¹Max Plank Institute for Polymer Research, Ackermannweg 10, D-55128 Mainz, Germany — ²PPMD-SIMM, UMR 7615 CNRS, UPMC, ESPCI ParisTech, 10 rue Vauquelin, 75231 Paris Cedex 05, France — ³CRPP, UPR 8641 CNRS, Universite Bordeaux 1, 115 Avenue Schweitzer, 33600 Pessac, France

We present measurements of the thermal fluctuations of the free surface of oil-in-water emulsions which exhibit a glassy behavior. The Surface Fluctuation Specular Reflection (SFSR) technique was applied to mea-

sure the free surface fluctuation. SFSR technique permits to probe the height of the fluctuations of liquid surface using the reflection of a laser beam projected on the target surface [1].

We found that when the volume fraction of the oil droplets is close to or larger than the disordered packing volume fraction, the free surface exhibits abnormal fluctuations, consisting of rare but large amplitude quakes. From a statistical analysis of the fluctuation signal, we also found that such large fluctuations become more prominent as the system ages. These quakes correspond to large changes in the local slope of the free surface over a few tenths of a second. We conjecture that such quakes reflect the dynamics peculiar to glassy systems driven by the relaxations of internal stress [2].

[1] A. Tay et al. Rev. Sci. Instrum. 79, 103107 (2008) [2] T. Kajiya et al. Soft Matter. 9, 11129 (2013).