DF 9: Glass II

Time: Tuesday 14:00–16:00

DF 9.1   Tue 14:00   WIL B321

Ion conductivity of Lithium-Borate glass layers in the nanometer thickness range — •GERD-HENDRIK GREIWE, FRANK BERKEMEIER, and GUIDO SCHMITZ — Institut für Materialphysik der Westf. Wilhelms-Universität Münster, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany

Specific ion conductivities of thin layers of Lithium-Borate-glasses with the compositions x Li$_2$O $\cdot$ $(1-x)$ B$_2$O$_3$, with $x = 0.15, 0.20, 0.25$ and 0.35, are determined by impendance spectroscopy as a function of temperature and layer thickness. The glass layers are prepared by ion-beam-sputtering in the thickness range from $7\,\mathrm{nm}$ up to $1000\,\mathrm{nm}$.

Previous measurements of our group demonstrated a significant increase of the specific conductivity with decreasing layer thickness. The increase is about three orders of magnitude and occurs for layers with a thickness under $\approx 100\,\mathrm{nm}$. Recent measurements show that this finite size effect only arises for Aluminium Lithium electrodes. In the case of Aluminium electrodes no significant thickness dependence appears. Therefore diffusion of Lithium from the electrodes into the glass-layers must be assumed as reason for the effect. In the talk different models for the concentration profile of Lithium inside the glass-layers are discussed to explain the observed finite size effect.

DF 9.2   Tue 14:20   WIL B321

Understanding the nature of ion conductivity in inorganic systems — •ANDREAS HEUER[1] and HEIKO LAMMERT[1,2] — [1]Institut für Physikalische Chemie, WWU Münster — [2]Center for Theoretical Biological Physics, San Diego

It is well accepted that the ion dynamics in inorganic ion conductors is based on ionic hops between adjacent sites provided by the network. It can be shown that the number of sites is only slightly larger than the number of ions [1]. Thus, it has been speculated that the ion dynamics should be described as a vacancy rather than a particle dynamics. This approach is elucidated in this contribution. First, a quantification of the vacancy dynamics has to be achieved. Whereas this is trivial for lattice models, several complications arise for continous systems. In this way one can identify, e.g., the relevance of cooperative ion jumps, corresponding to vacancy jumps beyond the nearest neighbor shell. Second, from studying the distribution of waiting times of a specific site as well as the patterns of forward-backward jumps one finds that the vacancy dynamics can be basically described as a single-particle problem (in contrast to the ionic motion). This result justifies the use of single-particle models such as the random-energy model to describe ion dynamics. Third, it is checked that the macroscopic conductivity can be described within a single-particle approach for the vacancies.
[1] H. Lammert, M. Kunow, A. Heuer, Phys. Rev. Lett. **90**, 215901 (2003).

DF 9.3   Tue 14:40   WIL B321

How important are facilitation processes for the dynamics in supercooled liquids? — •CHRISTIAN REHWALD and ANDREAS HEUER — Institut für Physikalische Chemie, Westfälische Wilhelms-Universität Münster, 48149 Münster

We investigate a binary mixture Lennard-Jones liquid by molecular dynamics simulation with respect to finite size effects. Our focus is the q-dependent relaxation time $\tau(q)$ and the diffusion constant D calculated from particle coordinates, inherent structures and metabasins [1]. It turns out that globally defined metabasins are no longer sufficient to predict $S(q,t)$ for large systems (except for small q). In order to avoid this problem, we calculate *local* exchange time distributions, generated by averaged particle displacements [2]. The locally defined distributions show a similar behavior as that of metabasins for long waiting times without depending explicitly on N. Moreover, as a result of facilitation processes, increasing the system size leads to a reduction of the long tails of the exchange time distribution. This N-dependence is exactly the one expected from a model glass-former based on a set of coupled elementary unit systems [3], which is e.g. implemented in several facilitated spin models.
[1] A. Heuer, Phys.: Cond. Mat. **20** (2008)
[2] L. O. Hedges *et al.*, J. Chem. Phys. **127** (2007)
[3] M. Vogel *et al.*, J. Chem. Phys. **120** (2004)

DF 9.4   Tue 15:00   WIL B321

Glass-Transition Scenarios for the Square-Shoulder System — •MATTHIAS SPERL — Institut für Materialphysik im Weltraum, DLR, Koeln

It was discovered recently that the competition of two mechanisms of glassy arrest can trigger glass-glass transitions if the two glasses are sufficiently distinct in their localization length. It was found in simulation and experiment that the interplay between hard-sphere repulsion and a short-ranged attraction can exhibit such a scenario. Here the competition between two repulsive length scales is considered. While for both very low and very high shoulders the hard-sphere limit is recovered, for specific widths and heights of the shoulder one can identify higher-order glass-transition singularities that are indicative of glass-glass transitions. In addition, multiple reentry scenarios are found: glass-liquid-glass transitions are possible both for constant density as well as for constant temperature. The results for the square-shoulder glass transition (and its generalizations) are expected to be relevant in micellar, metallic, and granular systems as well as in water.

This work is done in collaboration with E. Zaccarelli, F. Sciortino, P. Kumar, and H. E. Stanley.

DF 9.5   Tue 15:20   WIL B321

Lower critical dimension of the spherical spin glass — •FRANK BEYER and MARTIN WEIGEL — Institut für Physik, KOMET 331, Johannes Gutenberg-Universität Mainz, Staudinger Weg 7, 55099 Mainz, Germany

Considering $O(n)$ vector spin glasses, a major simplification of the free energy landscape occurs in the limit of an infinite number of spin components ($n \to \infty$), i.e., for the spherical spin glass. This simplification comes about through the fact that in the limit of a large number of spin components the ground state of a finite system occupies only a finite-dimensional subspace in spin space. As a consequence, for each system size there exists a finite, critical number n^* of spin components above which the ground-state energy does not change upon further adding spin dimensions, such that the system effectively describes a spherical spin glass. Here, this observation is exploited for investigating the stability of the ordered phase of the spherical spin glass as a function of the spatial dimension of the lattice. Using the concept of the defect energy, we numerically determine the stiffness exponents for lattices of various spatial dimensions $d = 2, 3, \ldots$ and use these results to estimate the lower critical dimension of the model. The results are compared to estimates resulting from field-theoretic calulcations.

DF 9.6   Tue 15:40   WIL B321

Relaxational dynamics of a fragile plastic crystal investigated by dielectric spectroscopy — •THOMAS BAUER, MELANIE KÖHLER, PETER LUNKENHEIMER, and ALOIS LOIDL — Experimental Physics V, Center for Electronic Correlations and Magnetism, University of Augsburg, 86135 Augsburg, Germany

In the present contribution, we report dielectric spectra on 60succinonitrile-40glutaronitrile (60S40GN), a binary mixture showing an orientationally disordered (OD) plastic-crystal phase with unusually high fragility [1].

Based on earlier works [2], the relaxation dynamics of OD materials generally seem to show rather strong characteristics within the strong-fragile classification scheme by Angell. However, the plastic crystalline phase of 60S40GN behaves unconventional in this respect and can be characterized as fragile [1]. This finding may be ascribed to a higher density of minima in the potential energy landscape, caused by substitutional disorder effects. Furthermore, the presented system is a good ionic conductor, showing decoupling between rotational and translational dynamics. In addition, while most other plastic crystalline phases show no or only a very weak secondary process [2], 60S40GN exhibits a well developed β relaxation.
[1] F. Mizuni, J.-P. Belieres, N. Kuwata, A. Pradel, M. Ribes, and C.A. Angell, J. Non-Cryst. Solids 352, 5147 (2006).
[2] See, e.g., R. Brand et al., Phys. Rev. Lett. 82, 1951 (1999); R. Brand et al., J. Chem. Phys. 116, 10386 (2002).