Particle Diffusion under Confinement of Porous Glass

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The transport of matter in porous structures is one of the most important processes in nature. A major part of studies published recently has been focused on transport, adsorption, wetting and demixing phenomena on a molecular level in meso- or microporous matrices, while the transport of larger molecules and especially of particles of larger dimensions has been rarely investigated. We applied dynamic light scattering as a non-invasive method to the investigation of the diffusion of polystyrene particles in controlled pore glasses (CPG) as a function of the tracer particle to pore size ratio. These micro- / macroporous glasses exhibit a bicontinuous randomly distributed microstructure and were saturated with mixtures of water and dimethylsulfoxide to achieve almost perfect optical matching. While the scattering of the glassy matrix vanishes under such conditions the polystyrene tracer particles show a suitable scattering intensity allowing for the implementation of a homodyne detection scheme. In the experiments two distinct diffusion modes can be identified which are related to the diffusion in the voids of the CPG grains and inside the CPG matrix, respectively, where the latter is significantly lowered in comparison to the free bulk diffusion. The diffusion coefficients within the confinement are quantified on basis of the ratio of particle to pore sizes.