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Analysis of H2O/D2O interaction with PNIPAM microgel thin films during swelling and exchange kinetics

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Microgels out of thermoresponsive polymers show a strong change in volume by a variation of the temperature across the lower critical solution temperature (LCST), which in a thin film geometry translates into a change of the film thickness. This offers new functionality and is of high interest in many different fields of application such as drug delivery or tissue growth. In order to gain detailed insights in the kinetics during the volume change, the diffusion of water molecules through the interconnected polymer network during the uptake and release of water is analyzed. Thin PNIPAM microgel films crosslinked with N,N'-methylenebisacrylamide are investigated with time-of-flight neutron reflectometry (TOF-NR) and Fourier transform infrared (FTIR) spectroscopy. H2O and D2O are used to apply different humidity conditions at a constant temperature below the LCST of PNIPAM and assure proper contrast between the low molecular penetrants for both measurement techniques. The H2O and D2O swelling as well as the H2O –D2O and D2O –H2O exchange processes are studied. Results from the TOF-NR analysis and the FTIR spectroscopy measurements are modelled with a model which accounts for the temporal evolution of the humidity and the diffusion speed of the low molecular penetrants through the polymer network.

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