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Evolution of a HP-SANS cell and its upgrade with a periodic pressure jump unit for soft matter studies

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Motivated by the patented idea of using scCO2-microemulsions as a starting material for the production of polymer nanofoams [1], we developed a new high-pressure cell together with Ralf Schweins and Peter Lindner in 2006. We were able to demonstrate its functionality in a first test SANS experiment at D11 in March 2007. In this and a series follow-up experiments we could show that scCO2-microemulsions containing water, supercritical carbon dioxide and fluoro-surfactants show similar properties as “classical” water/oil microemulsions [2]. However, using carbon dioxide, one exiting feature of scCO2-microemulsions is, that the solvent quality of scCO2 and hence the overall microemulsion properties, are tuned simply by adjusting pressure. Moreover, due to its large sapphire windows, we were also able to use the HP-SANS cell to study the dynamics of scCO2-microemulsions using NSE [3]. Further, in another study, we discovered that substituting cyclohexane with small amounts of scCO2 allows significant reductions in environmentally harmful fluorinated surfactants. Applying systematic contrast variation SANS, we were able to relate this effect to the formation of a depletion zone of cyclohexane near the fluorinated amphiphilic film [4]. Last but not least, we upgraded the high-pressure SANS cell with a periodic pressure jump system as part of the TISANE project. By combining this unique setup with time-resolved SANS, we were able to elucidate not only the kinetics of pressure-induced structural changes in scCO2-microemulsions [5], but also unravel the swelling kinetics of N-n-propylacrylamide-based microgels using periodic pressure jumps [6].
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