Structure and droplet dynamics in emulsified microemulsions

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Emulsified microemulsions represent systems reaching beyond the phenomena of self-assembly. We produce hierarchically organized structures by confining thermodynamically stable water-in-oil microemulsion droplets of a few nanometres in size to kinetically stabilized emulsion droplets of a few hundred nanometres. Prerequisite for the formation of self-assembly in confinement is a hydrophobic surfactant, in our case Phytantriol, building up equilibrium nanostructures that coexist with an excess-water phase. Applying common techniques leads to the emulsification of the respective nanostructure in its water-excess phase. To stabilize the emulsion droplets high molecular weight polymers or particles can be used. In contrast to ordinary emulsions, emulsified microemulsions are capable of solubilising either hydrophilic, hydrophobic or amphiphilic substances making them valuable delivery systems for any kind of technical application. The key to successfully bridge the gap between basic research and technical application is a fundamental understanding of hierarchical organization and the underlying physico-chemical principles. In the present contribution we present a systematic investigation of phase behaviour, structure and droplet dynamics of emulsified microemulsions. We have determined the water-solubilization capacity and size of the internal equilibrium nanostructure swollen with increasing amounts of tetradecane using optical detection and small angle X-ray scattering. Interfacial tension measurements allowed revealing the critical micelle concentration of Phytantriol in tetradecane as well as the effective head group area of Phytantriol at the water-tetradecane interface. On the basis of these data we were able to derive a first interpretation of the rather complex droplet dynamics in emulsified microemulsions investigated by light scattering, small angle scattering and neutron spin echo spectroscopy.