CO_2-based-surfactant-free microemulsions-like system as futurist universal green medium for chemical processes

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Abstract

Microemulsions are thermodynamically stable systems consisting of a ternary mixture of oil, water and a surfactant. They are macroscopically homogeneous, but microscopically structured. As they contain both, a polar and a nonpolar solvent, microemulsions can be considered as universal solvents and they have been extensively used either as commercial products or as reaction media for chemical processes.[1] Unfortunately, the purification of the products both from the organic solvent and from the surfactant is time and chemicals consuming. Minimizing the amount of surfactant and organic solvent used for preparing microemulsions is now on demand.[2] In our laboratories, the existence of "water-rich" nanodomains in equilibrium with "water-lean" nanodomains in the macroscopically homogeneous ternary mixture water/acetone/liquid CO_2 has been observed. These nanodomains have also shown the solvent capability of a microemulsion, solubilizing either hydrophilic or hydrophobic molecules.[3] The fine supramolecular structure of this new surfactant-free microemulsion-like systems has been determined through a combination of Raman Spectroscopy and SANS measurements. Molecular dynamics simulations studies have also supported the experimental findings, clarifying the interactions among the components. It has been found that the composition as well as the working conditions (temperature and pressure) can be used as tools for tuning the fine structure of such microemulsions. Furthermore, other solvents in presence of water and compressed CO_2 have shown a similar behavior to that of acetone, extending the range of applications of such systems. The systems here presented have the potential of behaving as nanoreactors for particles formation and becoming green universal solvent for chemical processes, showing the solvation properties of both bulk water and organic solvents and the attractive pressure tunable characteristics of compressed CO_2, without the recourse to surfactants.

References

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