Colloids and Surfaces A: Physicochem. Eng. Aspects 418 (2013) 157–164

Contents lists available at SciVerse ScienceDirect

Colloids and Surfaces A: Physicochemical and Engineering Aspects

journal homepage: www.elsevier.com/locate/colsurfa

Extended Q-range small angle neutron scattering from inverse micellar solutions of PIBSA—Micelle and molecular scattering

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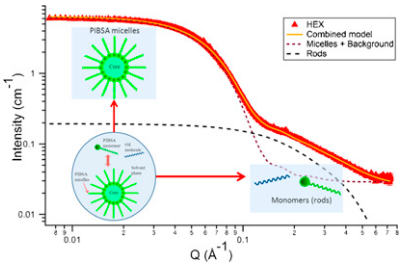
HIGHLIGHTS

- First SANS study from inverse micelle system to reveal location of all surfactant.
- Rod-like signal from single dissolved surfactant and solvent molecules observed.
- Volume fractions of rods/micelles, incoherent background, agree with compositions.
- Solvency effect on micellar–monomer (rod) equilibrium has been studied.
- Quantitative value of extended Q range, high signal-to-noise SANS experiments.

GRAPHICAL ABSTRACT

Extended Q – small angle scattering (SANS) with enhanced signal-to-noise has revealed the detailed structure of polyisobutylene-based surfactant (PIBSA) inverse micellar solutions. The figure illustrates the SANS patterns for PIBSA in hexadecane solutions at 20 °C and fitting associated with its constituents. The fitting model accounts for the scattering from rods, micelles and background from PIBSA solutions.



ARTICLE INFO

Article history:
Received 13 September 2012
Accepted 20 November 2012
Available online 29 November 2012

Keywords:
Inverse micelles
High internal phase emulsions
Molecular conformation
PIBSA
SANS (Small-angle neutron scattering)

ABSTRACT

Inverse micelles play an important role in the stability of high internal phase water in oil (W/O) emulsions. The influence of both solvent and temperature has been investigated on the structure of inverse micelles prepared from the polyisobutylene-based surfactant, PIBSA, using small-angle neutron scattering (SANS). By collecting data over an extended range of scattering vector (Q), combined with the use of solvent deuteration, SANS has highlighted an additional contribution to the anticipated micellar scattering, namely a signal characteristic of rod-like scattering that is consistent with single dissolved molecules of the PIBSA surfactant and its primarily hydrogenated (mainly alkane oil) solvent (both MW ca. 1000 Da). The solvency effect of three different solvents (hexadecane, cyclohexane and toluene) on micellar–monomer (rod) equilibrium has also been evaluated. The volume fractions of rods and micelles in solution are found to agree with the sample compositions, as does the intensity of the observed incoherent background. This consistency across fit parameters not only highlights the sensitivity of the model but also the value of extended Q range, enhanced signal-to-noise studies in such soft matter systems. The data show the extent to which quantitative measurements can be carried at the molecular level using small angle scattering.

1. Introduction

High internal phase emulsions (HIPEs) are industrially important in areas as diverse as explosives, food products and toiletries. For some time we have been examined the structure and properties of these materials by various techniques, but predominantly

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0927-7757/$ – see front matter.
http://dx.doi.org/10.1016/j.colsurfa.2012.11.034