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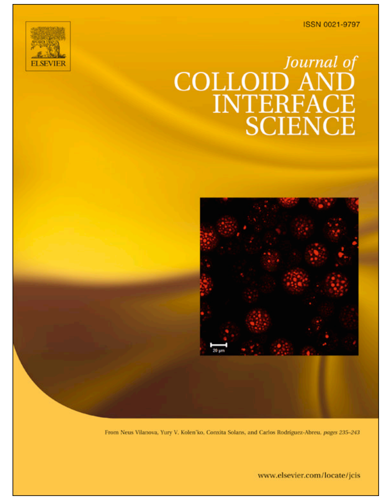

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Flow-induced concentration gradients in shear-banding of branched wormlike micellar solutions

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ABSTRACT

Hypothesis: Shear-banding of branched wormlike solutions is a topic of active investigation which has not been fully elucidated. Here, we surmise that flow-induced microstructuring in the shear banding regime is associated with spatial concentration gradients.

Experiments: The experiments focus on the flow-induced behavior of a CTAB/NaSal wormlike micellar system. A unique approach based on a microfluidic-spitter geometry, combined with particle-image velocimetry and high-speed video microscopy, is used to separate the streams flowing out from the core and the near wall zones of the microchannel.

Findings: Here, we present the first direct experimental evidence of the correlation between phase separation and shear banding. By increasing the pressure-drop across a microcapillary, the onset of a grainy texture close to the wall, showing a flow-induced demixing effect, is observed. We use a splitter to measure effluent streams from the center and the near-wall zones in terms of viscosity, conductance and dry mass. We observe that phase-separation induced by the flow correlates with chemical concentration gradients. This confirms our hypothesis that shear-induced local de-mixing of the system is strongly related to chemical concentration gradients.

1. Introduction

The process of self-assembly, which plays a key role in the field of soft matter[1], has attracted a special interest in the area of surfactants due to their ubiquitous applications in daily life. Self-assembly in solution, which occurs when surfactant concentration is increased above a critical micellar value (CMC), causes the formation of a wide variety of supermolecular structures[2]. In particular, at these concentrations (>CMC), molecules tend to form aggregates in order to minimize the contact between water and surfactant tails.

Surfactant geometrical properties, i.e. head-area and tail-volume, can be affected by a number of parameters, such as pH, temperature, and electrolytes in the solution. For fixed geometrical properties, shape and size of surfactant-aggregates can be predicted by a dimensionless number, the packing parameter p, which can be defined as $v/(l_c \cdot a_s)$, where v is the volume of the lipophilic