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Effect of Interfacial Mobility on Film Drainage During Drop Coalescence

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Introduction

Drop coalescence is very important for many industrial and natural processes, and its prediction and control is of great practical importance. The drainage of the film between the colliding drops is the time determining step in drop coalescence. It is governed mainly by the interfacial mobility.

Materials and Methods

Silicon oil with viscosity of $1 Pa.s$ is used as a continuous phase, while a series of polyethylene oxide (PEO) water solutions with different viscoelasticities are used as dispersed phase (Table 1). The concentrated PEO polymer solutions have viscosity ratios to the continuous phase indicating partially mobile regime(Fig.1).

- immobile ($\lambda > 10^4$): drop viscoel. not relevant
- transition ($10^2 < \lambda < 10^4$): drop viscoel. relevant?
- partially mobile ($10^{-2} < \lambda < 10^2$): drop viscoel. significant?
- fully mobile ($\lambda < 10^{-2}$): drop viscoel. not relevant

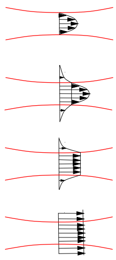

Figure 1. *Interfacial mobility according to Chesters [1], where $\lambda = \mu_d/\mu_c$ is drop to continuous phase viscosity ratio.*

water solution	dissolving procedure	t_r [s]	λ	γ [mN/m]
PEO 0.55 $wt\%$	stirred	63	30	24.0
PEO 0.60 $wt\%$	not stirred	125	75	26.5
PEO 0.65 $wt\%$	stirred	80	60	25.1

Table 1. *Material properties: t_r is the relaxation time of the polymer solutions and γ is the interfacial tension between the solutions and the silicon oil.*

The film deformation and drainage are visualized by an interferometric technique:

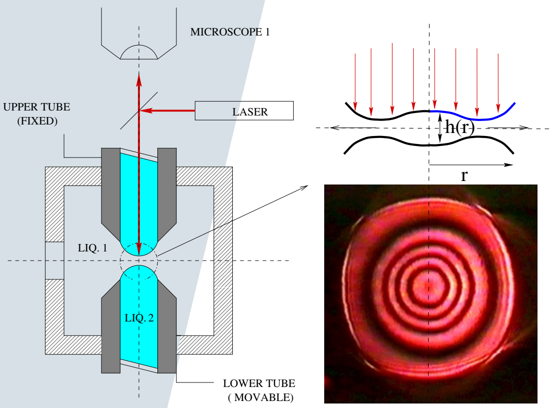

Figure 2. *The experimental set up and a resulting interference pattern.*

Results

The interferometric images are recorded and when a rupture occurs the film profile is reproduced by counting the Newton rings backward.

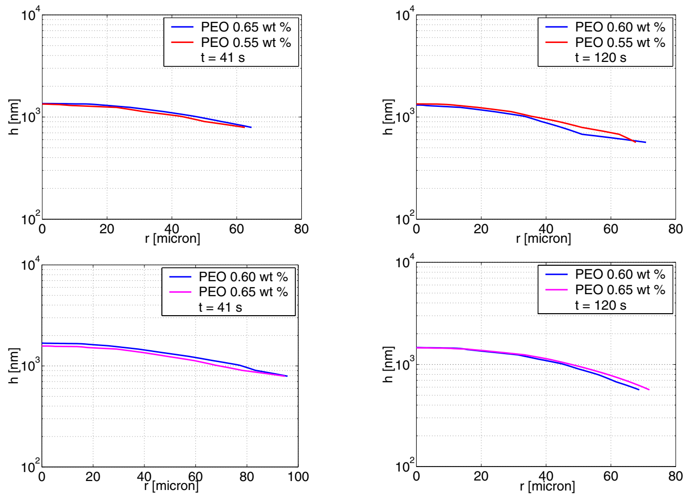

Figure 3. *Comparison of the film profile for the different polymer solutions.*

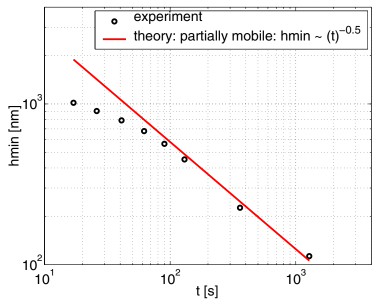

Figure 4. *Comparison of the film drainage at the rim of the film with a long-time asymptotic theory for partially mobile interfaces.*

Conclusions

- with increasing viscoelasticity of the polymer solutions interfacial tension also increases (Table 1), indicating contraction of the polymer from the interface.
- film deformation is the same for different polymer solutions (Figure 3), indicating that the dispersed phase does not influence the drainage process.
- the good fit in Figure 4 shows that the interfaces are partially mobile.
- from the first three outcomes one can conclude that there is a lubrication layer at the interface, leading to faster drainage.

References:

[1] CHESTERS, A.K.: *Transactions of the Institution of Chemical Engineers. Part A*, 1991, 69, 259-270.

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