

# Influence of interfacial tension on coalescence of polymer blends

***Citation for published version (APA):***

Tufano, C., Peters, G. W. M., & Meijer, H. E. H. (2005). *Influence of interfacial tension on coalescence of polymer blends*. Poster session presented at Mate Poster Award 2005 : 10th Annual Poster Contest.

***Document status and date:***

Published: 01/01/2005

***Document Version:***

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

***Please check the document version of this publication:***

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

***General rights***

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

[www.tue.nl/taverne](http://www.tue.nl/taverne)

***Take down policy***

If you believe that this document breaches copyright please contact us at:

[openaccess@tue.nl](mailto:openaccess@tue.nl)

providing details and we will investigate your claim.

# Influence of interfacial tension on coalescence of polymer blends

C. Tufano, G.W.M. Peters and H.E.H. Meijer

Eindhoven University of Technology, Department of Mechanical Engineering

## Introduction

Interfacial tension of polymer blends is affected by mutual solubility which, in many cases in literature, is assumed negligible. This assumption is not completely correct if we consider a large asymmetry in molecular weights of the two components. The goal of this work is to study the evolution of interfacial tension with time as a function of molecular weight asymmetry across an interface in order to understand morphology development during mixing.

## Materials

Polymer Blend	Dispersed phase/ Continuous phase	$M_n$
Extremely Diffusive	PB/PDMS	635/62700
Slightly Diffusive	PBD/PDMS	8000/62700
Reversed ED	PDMS/PB	62700/635
Reversed SD	PDMS/PBD	62700/8000

## Techniques

Interfacial tension is measured with a pendent/sessile drop apparatus (Fig.1 a). The time dependent drop shape is fitted using Gauss-Laplace equation giving the interfacial tension. The time evolution of the average radius is obtained from SALS patterns (Fig.1 b) applying Debye-Bouche theory and from optical microscopy measurements.

### Gauss-Laplace equation:

$$\sigma (1/R_1 + 1/R_2) = \Delta P_0 + \Delta \rho g z$$

$\sigma$ : interfacial tension

$R_1, R_2$ : radii of curvature

$\Delta P_0$ : pressure difference in a reference plane

$\Delta \rho$ : density difference

$g$ : gravity acceleration

$z$ : vertical height of the drop

### Debye - Bauche equation:

$$I(q) = K \xi^3 [1 + (q\xi)^2]^{-2}$$

$K$ : a function of the scattering contrast

$q$ : scatter vector magnitude

$\xi$ : structure correlation distance

$$R^2 = 10\xi^2$$

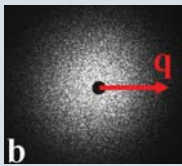
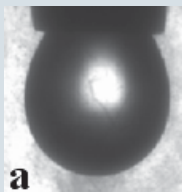


Fig. 1. a: Pendent drop configuration. b: typical SALS pattern.

## Results

### $M_n(\text{dispersed phase}) < M_n(\text{continuous phase})$

Short molecules diffusing from the drop into the matrix determine the interfacial tension evolution with time and this affect morphology. At constant temperature and at constant viscosity ratio, the phenomenon is more pronounced in the ED blend (Fig.2).

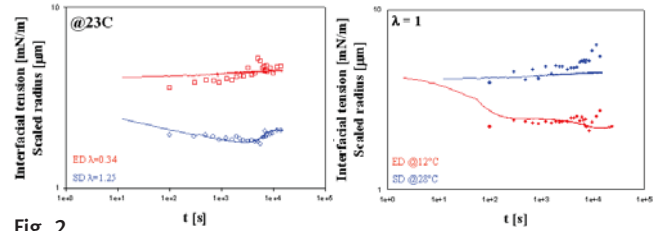


Fig. 2.

### $M_n(\text{dispersed phase}) > M_n(\text{continuous phase})$

Short molecules diffuse from the matrix into the droplets but due to the fast saturation of the dispersed phase diffusion doesn't play any role and coalescence determine the morphology (Fig.3).

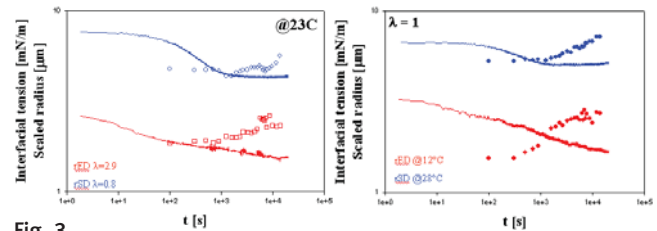


Fig. 3.

## Mathematical Models

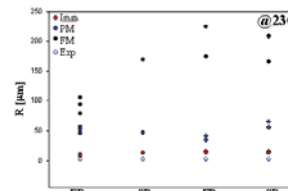
Drop radii are calculated from a drainage model. Three cases: immobile, partially mobile and fully mobile interfaces.

$$R_{Imm.} = (8/9)^{1/4} * h_{cr}^{1/2} * (\eta_c * \dot{\gamma} / \sigma)^{-1/2}$$

$$R_{P.M.} = (4/\sqrt{3} * \dot{\gamma})^{2/5} * \lambda^{-2/5} * (\eta_c * \dot{\gamma} / \sigma)^{-3/5}$$

$$R_{F.M.} * \ln(R_{F.M.} / h_{cr}) = 2/3 * (\eta_c * \dot{\gamma} / \sigma)^{-1}$$

The initial, the minimum and the "plateau" value of  $\sigma$  have been plugged in the model (Fig.4).



$\eta_c$ : viscosity continuous phase

$\dot{\gamma}$ : shear rate

$\sigma$ : interfacial tension

$h_{cr}$ : critical film thickness

$\lambda$ : viscosity ratio

Fig. 4. Calculated drop radii compared with the experimental values.

## Conclusions

- With lower  $M_n$  polymer as dispersed phase interfacial tension changes in time.
- By reversing the phases, diffusion becomes a minor phenomenon and does not play any role in defining the morphology.
- Existing mathematical models do not apply.

This knowledge can be used to understand and, moreover, to control blend morphology.