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A fast and accurate Langmuir-type polymer microtensiometer

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Abstract

A semi-flexible polymer microtensiometer for local surface pressure measurements of Langmuir monolayers is presented. The current device geometry and read-out method via image analysis result in a theoretical accuracy of $\pm 0.02 \text{ mN}\cdot\text{m}^{-1}$ for a dynamic range between 0 and $75 \text{ mN}\cdot\text{m}^{-1}$. The tensiometer sensitivity and dynamic range are easily tunable as they are solely based on the tensiometer spring dimensions. Finite element simulations are used to determine the response time of 20 ms for a subphase viscosity of $1 \text{ mPa}\cdot\text{s}$. A poroviscoelastic model of the sensor is composed and the subphase viscosity is shown to dominate the transient behaviour. The tensiometer performance is verified in a Langmuir trough by applying rapid local surface pressure oscillations. A Wilhelmy plate is used as an independent measurement tool and the results of both techniques correlate well.

Keywords: Tensiometry, Surface tension, Interfacial tension, Surface pressure, Response time, Dynamic range, Viscosity

1. Introduction

Surface tension shapes the world around us. It is the physical property that gives a fluid surface an elastic nature and causes it to minimize its surface area. Among many other things, surface tension is responsible for the shape and size of rain drops and insects walking on water. When two immiscible fluids are brought in contact (e.g. oil and water), the term interfacial

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