

Controlling thin liquid film viscosity via modification of substrate surface chemistry

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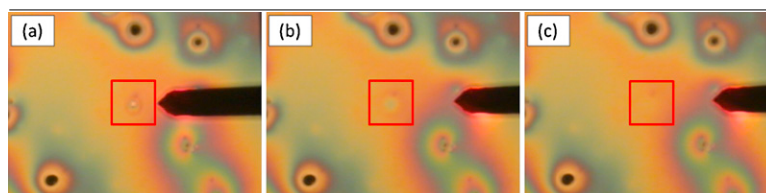
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HIGHLIGHTS

- ▶ Thin films of spin-deposited silicone fluids.
- ▶ Silicon and fluoropolymer-coated silicon substrates.
- ▶ Perturbation applied to film using colloid probe atomic force microscopy.
- ▶ Film viscosity estimated from time required for recovery of the perturbation.
- ▶ Thin film viscosities can be controlled via selection of substrate surface chemistry.

GRAPHICAL ABSTRACT



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ABSTRACT

The viscosity of thin films of liquid poly(dimethylsiloxane) have been studied on silicon and fluoropolymer-coated silicon by means of a perturbation technique applied using colloid probe atomic force microscopy. The liquid film supported by a silicon substrate exhibited a greater viscosity than the bulk liquid, due to the strong interaction between the molecules near to the liquid/solid interface. In comparison, the liquid film supported by a fluoropolymer-coated substrate exhibited a similar viscosity to the bulk liquid, due to the weak interaction between the liquid and the fluoropolymer surface. This demonstrates the possibility to control the viscosity of thin liquid films via selection of the substrate chemical properties.

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1. Introduction

Thin film structure and dynamics are topics of significant research interest, with applications in fields as diverse as electronics, healthcare technologies and biomedical engineering. It is well-established that the properties of ultrathin films can vary as a function of the film thickness [1–4] with polymer chain seg-

ments at the film/substrate interface exhibiting decreased mobility compared with the bulk film, whereas segments at the free surface exhibit greater mobility than the bulk film. The effect of this anisotropy affects the properties of materials which include viscosity [1], glass transition temperatures [2–3], diffusion coefficients [4], and rheological properties [5]. For systems where there was a favourable interaction between the film and the surface chemical moieties of the supporting substrate, the properties of the film differed from those of the bulk. Granick and co-workers have employed techniques such as the surface forces apparatus and extensively studied the properties of polymer melts, show-

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