Controlling interface pinning by surface heterogeneities

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Abstract: Doctor blade technique is widely use to coat surface. However the understanding of the interface pinning on surface heterogeneities is still elusive. This work aim to give a better understanding of the process occurring when a liquid interface crosses a heterogeneity while dragged along a surface. For that, large-scale molecular dynamics simulations are used to track the key parameters that determine the movement of a liquid meniscus on a heterogeneous substrate and to give detailed insight of the pinning phenomenon.

Keywords: wetting dynamics, heterogeneities, doctor blade, surface coating, molecular dynamics

Introduction

Understanding and controlling the pinning of a liquid interface on an heterogeneity is crucial for numerous applications such as anti-reflection coating **[1]** or self-assembled plasmonic structures **[2]**. An example is the doctor blade coating technique which as been used in recent years to deposit nanoparticles on patterned surfaces **[3]**. This work focus on the understanding of the receding interface movement at the edge of a heterogeneity using large-scale molecular dynamics simulations.

Results and Discussion

We consider here two types of heterogeneities, chemical and physical. Our simulations clearly show that a receding interface is pinned on the edge of a heterogeneity if the contact angle is not in agreement with the one required to cross the structure.

In the case of a chemical heterogeneity, the contact line arrives near the heterogeneity with a contact angle determined by the internal flow in the liquid and the equilibrium contact angle of the surface. When the interface arrives on the heterogeneity, it remains pinned until its contact angle reaches the equilibrium contact angle of the heterogeneity as shown in figure 1.

In the case of a physical heterogeneity, the behaviour is identical. Here, the contact line will be pinned until the contact angle regarding the vertical plane forming the pinning structure attains the equilibrium value for this plate.

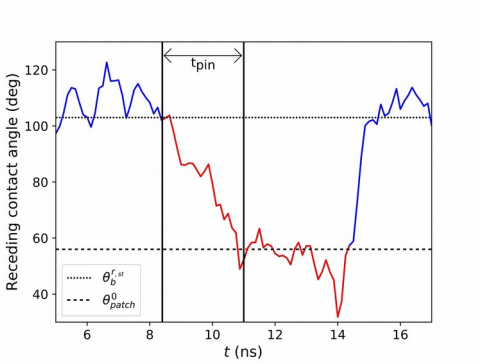

Figure 1: *Evolution of the contact angle of a receding interface while dragged across a surface (blue) containing a heterogeneity (red).*

Conclusions

The pinning of an interface on a heterogeneity can be see as a direct consequence of contact angle difference. This opens the way to a better understanding of a interface movement on an heteregenous surface which is required to optimize that use it.

References

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Acknowledgements

This research was partially funded by UMONS Computational resources have been provided by the Consortium des Equipements de Calcul Intensif (CECI), funded by the Fonds de la Recherche Scientifique de Belgique (F.R.S.-FNRS) under Grant No. 2.5020.11