DOCTOR BLADE TECHNIQUE AND WETTING DYNAMICS

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The controlled deposition of nanoparticles to form ordered 2D patterns free of defects is a challenging topic with myriad of applications as antireflection coatings [1], plasmonic surfaces [2], electronic [3], etc. However, the process throughput and the scalability are limited for real industrial applications.

Recent studies [4] have shown the viability to deposit nanoparticles with great spacial precision on patterned surfaces by using the doctor blade method where a meniscus of a liquid containing the nanoparticles is forced to move through a substrate. The combination of the resulting flow, the wetting dynamic at the receding contact line, the contact line pining plus the evaporation leads to the nanoparticles deposition.

However, in order to optimize this method and to increase the velocity of the particle deposition it seems necessary a better understanding of the different mechanisms acting at the receding contact line.

In this work we use large-scale molecular dynamic simulations to model the doctor blade technique at the nanoscale. We focus in the study of a pure liquid confined between two plates. The moving of the top plate at constant velocity induce a flow and the displacement of the liquid along the bottom plate where we introduce different chemical and physical heterogeneties. This simple system allow us to analyze the dynamic of the different contact angle of the system as well as to study the contact line pining on the different heterogeneties. We develop a theoretical model to predict the dynamic contact angles as a function of the affinity between the liquid and the different plates and the velocity of the top plate. Finally, we have studied the mechanism behind the pinning of the receding contact line at the nanoscale as well as the posibility of controlling the pinning time by tunning the wettability of the substrate. The results obtained open the door to optimize the doctor blade technique for a faster nanoparticle deposition process.

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