Anti-wetting surfaces fabricated by Reverse Nanoimprint Lithography on Silicon and metal-coated substrates

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Reverse Nanoimprint Lithography (RNIL) is a well-established technique, which has been used to imprint selectively thin polymer films over flat and or pre-patterned surfaces[1]. The unique feature of this modified nanoimprint lithography technique is the possibility to control the presence or absence of a residual layer. Moreover, the capability of sequential imprinting over pre-patterned surfaces resulting in three-dimensional structuring by RNIL has been demonstrated[2]. In this paper we report a further development of the RNIL technique to pattern micro/nano scale polymer patterns over metal substrates without a residual layer and test them as anti-wetting surfaces.

In this work we demonstrate that RNIL is a feasible and flexible lithography technique applicable to transfer micro and nanometer-scale polymer structures with no residual layer over cm^2 areas on silicon and metal substrates. We used two different flexible Polydimethylsiloxane (PDMS) stamps, one with positive and the other with a negative relief, which have honey comb-like hydrophobic features. Despite the fact that our stamp has a design which repels water, we were able tofine tune the surface properties of the PDMS stamps to deposit uniformly the resist on them. In this regard, surface functionalization of the flexible stamp by organic solutions proved to be useful, reducing the contact angle between the resist and the stamps surface by 31%, leading to a clear improvement of the RNIL results (Figure 1*)*.

We present RNIL results of anti-wetting surfaces, which were imprinted using the commercial resist mr-NIL6000E (*microresist technology GmbH*) over silicon wafers (Figure 2) and over Nickel-coated steel wafers leaving no residual layer. Moreover, we discuss the imprinting parameters and alleviate some of the main problems previously identified, such as: residual layer or pattern distortion. Specifically, our imprinting temperature was set to a value close to that of the resist's glass transition (T_g = 40 ^oC) and the pressure was kept as low as 2 bar, reducing the undesired spread and pattern alteration. Small pressures also help to minimize the "sagging" phenomenon, which is directly responsible for the presence of residual layer[3]. Both positive and negative patterns of honeycomb lattice features were successfully transferred showing hydrophobic properties, with contact angles 115^o and 91^o, respectively.

Acknowledgments

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References

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Figures

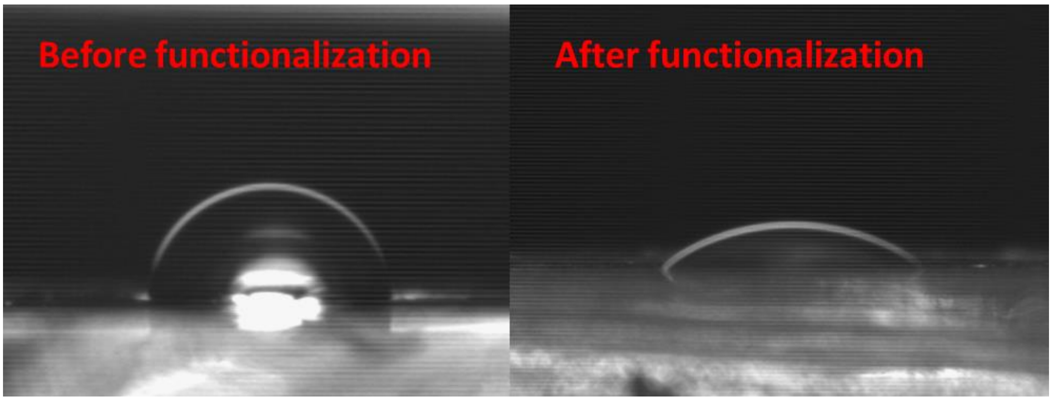

Figure 1: Contact angles between the resist and the PDMS stamp before (left) and after (right) the surface functionalization.

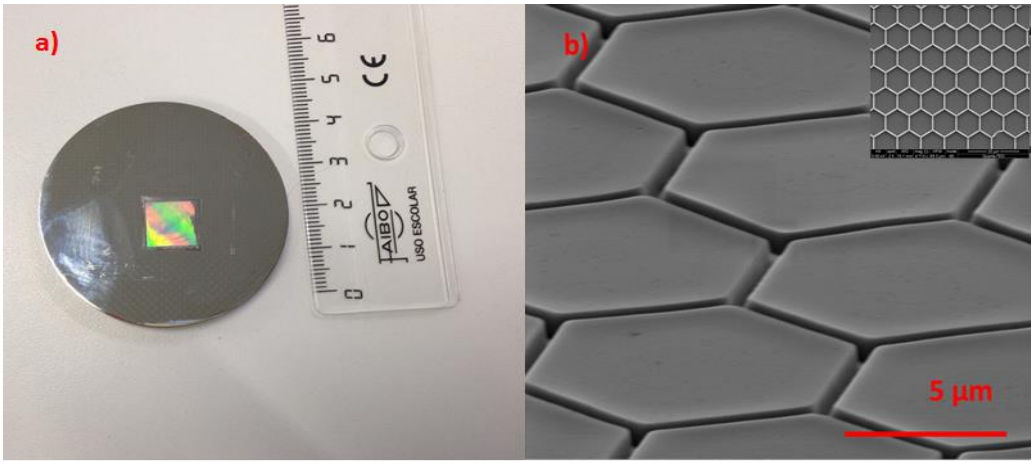

Figure 2: a) Photograph of a 1.2 x 1.2 cm^2 pattern transferred on a Nickel-coated steel substrate, b) tilted scanning electron microscope (SEM) image of a positive hydrophobic pattern transferred by RNIL on a silicon wafer with no residual layer (inset: top view SEM image showing the transfer of a negative anti-wetting surface with patterned line widths of 500 nm and no residual layer).