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Liquid-transfer Nanoimprint Lithography on Prestructured Substrates.

ABSTRACT - Masterthesis

Nanoimprint Lithography is a method to replicate nanostructures on large area. This can be done by pressing a nanostructured stamp into a soft (UV-curable) polymer on a substrate. While the stamp is in contact with the polymer, the material can be cured by e.g. UV-irradiation and then the stamp is removed, resulting in a nanostructured hard polymer on the substrate. Usually the substrate is coated with the UV-curable imprint polymer, e.g. by spin coating, droplet dispensing or inkjet printing. However for certain applications it can be advantageous to coat the stamp rather than the substrate, which is then called reversal NIL. This procedure is especially advantageous if NIL is to be performed on top of existing nanostructures, while preserving these. It is usually not possible to do the coating directly on top of already existing nanostructures without filling up these structures. However, reversal NIL is challenging since the Nanoimprint stamps are designed in such a way to exhibit anti sticking properties, making homogeneous coating difficult. A variant of reversal NIL, so-called liquid-transfer imprint lithography, might be a solution for this problem.

The principle of LTIL is that initially a flat substrate is spin coated with the UV-curable resin (so-called donor wafer). The LTIL process uses a flexible stamp, which is brought into contact with the resin layer on the donor wafer. This stamp is peeled off from the donor wafer and a thin layer of liquid UV-curable resin stays on the stamp, which is then transferred to the target substrate and the resin is cured by UV radiation, finalizing the LTIL process. However, this process can be used to combine the optical effects by grating the line and space structures(or T-structures) on top of the diffusor foil structures under right mechanical properties of the stamp and imprint material.

The goal of the thesis is to establish a liquid transfer nanoimprint lithography process for nanoimprinting on prestructured, rough substrates.

Tasks

1. Prepare the stamps for LTIL
1.1. Prepare stamps on Polydimethylsiloxane (Sylgard 184) and also using JR5 to prepare the stamps on a polymer backplane to do the imprinting, i.e. making a copy of the master
1.2. Testing different polymeric backplanes
2. Optimize the LTIL process
2.1. Varying the coating parameters of the donor wafer
2.2. Optimizing the contacting and removal procedure of the stamp
2.2.1. Stamp – donor wafer
2.2.2. Stamp – substrate (incl. UV-curing)
2.3. Imprinting on flat and prestructured substrates
3. Prepare the prestructured substrates
3.1. Preparing the stamps from the relevant master
3.2. Using conventional UV-nanoimprint lithography on glass substrates and/or polymer foils
3.3. Choosing the material to be compatible with the LTIL material and process
4. Characterize the imprinted features
4.1. Using optical microscopy, profilometry and AFM

The work was performed in the cleanroom (preparing stamps and doing nanoimprints, optical microscopy) and outside (AFM characterization, profilometer, optical microscopy)