Nanostructures in seven-league boots - the potential of R2R-UV nanoimprinting

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R2R nanoimprint lithography has proven to be a very powerful tool for the realization of micro/nanostructures on flexible substrates and large surfaces with high throughput. In this context, hierarchical structures, e.g. microstructures with superimposed nanoscale properties, are of particular interest as they are the key to many bionic, microfluidic and optical effects. Thus, the drag resistance of objects moving fast in fluids can be reduced by hierarchical structures on the surface, or the wettability of liquids on hierarchically patterned surfaces can be adjusted from superhydrophobic to superhydrophilic. The latter (spontaneous wetting) is a property that can be used for manipulating ink and fluid transport (microfluidics), for the definition of functional microstructures like microelectrodes and for multilevel patterning. One key prerequisite for a versatile deployment of R2R UV-nanoimprinting is the adjustability of the imprint resin towards the targeted application scenario. It should be tunable in terms of elasticity and surface tension to account for easy demolding and for low (water-repellant) as well as high (water-wicking) energy surfaces and it should have low enough viscosity to allow for large-area coating. For optical polymer components such as free-form micro-lenses or light outcoupling / reflecting structures the tuneability of the refractive index and the dispersion are important as well. Moreover, long-term stability with respect to process durability of the polymer and Ni stamps, weather resistance of the patterned film surfaces in terms of scratch resistance and UV-stability and pattern fidelity of the structures with regard to shrinkage of the resin are very important aspects influencing the deployment of the R2R-UV-NIL process.

We will demonstrate the potential of R2R-UV-NIL in a number of applications ranging from fabrication of microfluidic structures for lab-on-chip devices to embedding of metal structures for printed electronics and verify these by simulation. Furthermore, we report on the utilization of UV-NIL for the upscaling of freeform microoptical components in lighting, decorative, biosensing and electronic applications.