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High-throughput production of microfluidic chips by roll-to-roll based processes

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Microfluidic systems promise revolutionary new approaches for measurement devices- compact, portable and with low sample consumption. Anyhow, the concept often bases on exchangeable single use chips. A break through of the technology is only expectable if the chips can be produced at low prices. Current chip manufacturing often bases on low throughput processes with single chip operations. Hence, complex chip handling steps need to be included in the production line. In this contribution, high throughput manufacturing of microfluidic chips based on roll-to-roll (R2R) imprinting is presented. In a process called roll-to-roll based ultraviolet light assisted nano imprint lithography (R2R UV NIL) the surface pattern of a cylindrical stamp is continuously pressed to a polymer film, which got coated with a liquid resin. This resin is cured by UV radiation during contact with the stamp. After detaching the cured material from the stamp the microfluidic pattern got replicated. This process allows for parallel production of microfluidic patterns of several hundred chips per minute. The concept of parallel production on large polymer foils is also applied to the following process steps like electrode or biomolecule printing, inlet cutting and bonding technology. Hence, chips are not produced in single chip processes with complicated handling-production with high degree of parallelization is realized instead. The technology is demonstrated in versatile applications from medical diagnostics, environmental analysis as well as cell cultivation (organ-on-a-chip). In summary, the presented technology shows a way to future low cost manufacturing of microfluidic chips-combining large area imprinting of microfluidic patterns with large area printing processes of electrodes or biomolecules-all costly steps of individual chip handling are avoided. This can be a key to future low cost fabrication of microfluidic chips and therefore enable a broad market success of the technology.

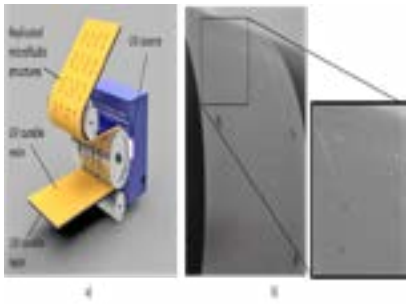

Figure: 1. (a) Schematic of the Roll-to-Roll (R2R) imprinting process used for high-throughput production of microfluidic channels and chambers..

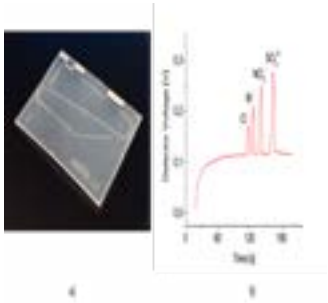

Figure: 1. (b) A capillary electrophoresis chip in foil design from R2R production.

Recent Publications

1. Leitgeb M, Nees D, Ruttloff S, Palfinger U, Gotz J, Liska R, Belegratis M R and Stadlober B (2016) Multilength scale patterning of functional layers by roll-to-roll ultraviolet-light-assisted nanoimprint lithography. ACS Nano 10(5):4926-41.
2. Smolka M, Puchberger-Enengl D, Bipoun M, Klasa A, Kiczkajlo M, Smiechowski W, Sowinski P, Krutzler C, Keplinger F and Vellekoop M J (2016) A mobile lab-on-a-chip device for on-site soil nutrient analysis. Precis. Agric. 18(2):152-68.

Biography

Martin Smolka is a Researcher at the Materials Institute of Joanneum Research in Austria. He has his expertise in microfluidic sensors for various applications like environmental and medical analysis. He currently coordinates the European research project R2R Biofluidics focusing on high throughput production of microfluidic chips by roll-to-roll based processes for imprinting of microfluidic channels, biomolecule printing and lamination.

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