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ROLL-TO-PLATE FABRICATION OF MICROFLUIDIC CHIPS WITH THIOL-ENE RESINS

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Abstract
We demonstrate the production of microfluidic chips with a UV-assisted roll-to-plate fabrication approach. Patterning and lamination of the chip can be performed with fabrication speeds of up to 19 m/min (ca. 20 chips/min), offering a rapid and simple production method for medium to high volume chip fabrication. The applicability of this roll-to-plate process is demonstrated with the fabrication and testing of a capillary electrophoresis chip.

1 Introduction

Thiol-ene resins are photocurable polymers, which can be polymerized in a light induced step growth reaction. Their surface functionality can easily be tuned by an off-stoichiometric monomer ratio, leading to an excess of either allyl or thiol anchor groups for further immobilization of, for example, biomolecules. So far, thiol-ene-based microfluidic chips have been fabricated in a manual casting process using PDMS molds.

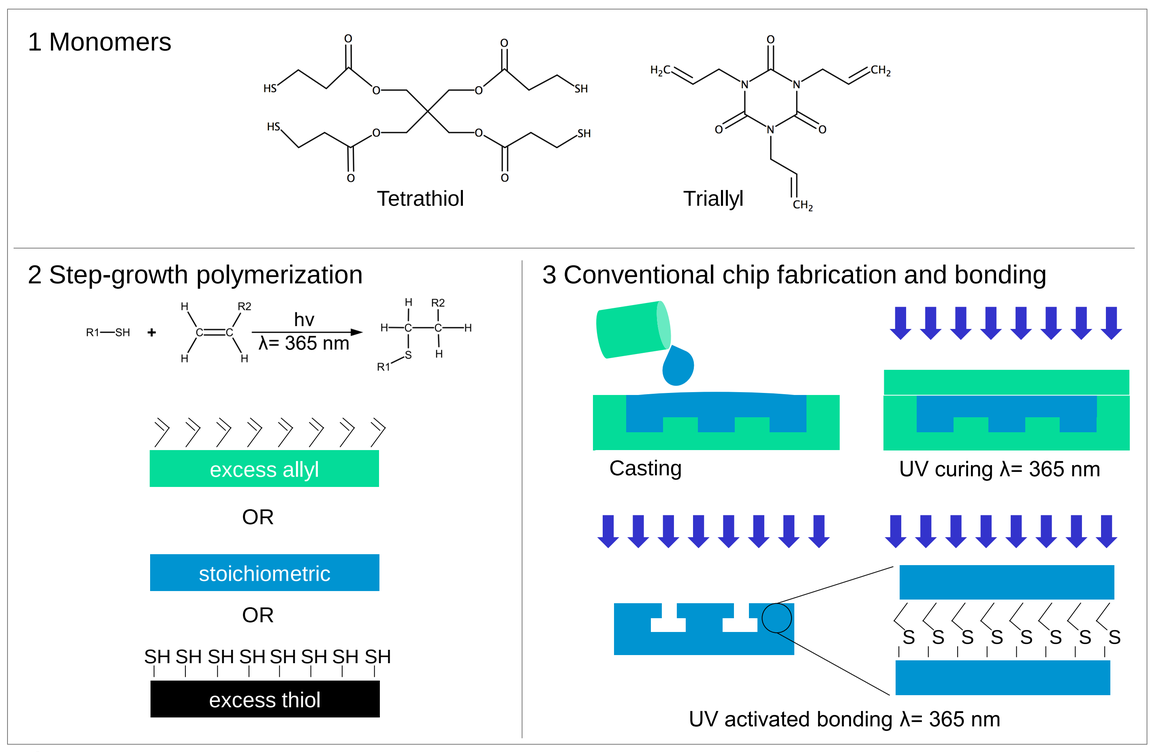

Fig. 1
1) Monomers used for polymerization **2) Step-growth polymerization** via UV activated thiol-ene click reaction. Off-stoichiometric monomer ratios to yield functional polymer surfaces. 3) **Conventional chip fabrication and bonding** of thiol-ene chips with PDMS molds. Covalently bonded chips via thiol-ene click mechanism.

2 Template fabrication

In contrast to the conventional PDMS casting mold, a thin, transparent and flexible mold (template) is required for a roll-to-plate fabrication approach.

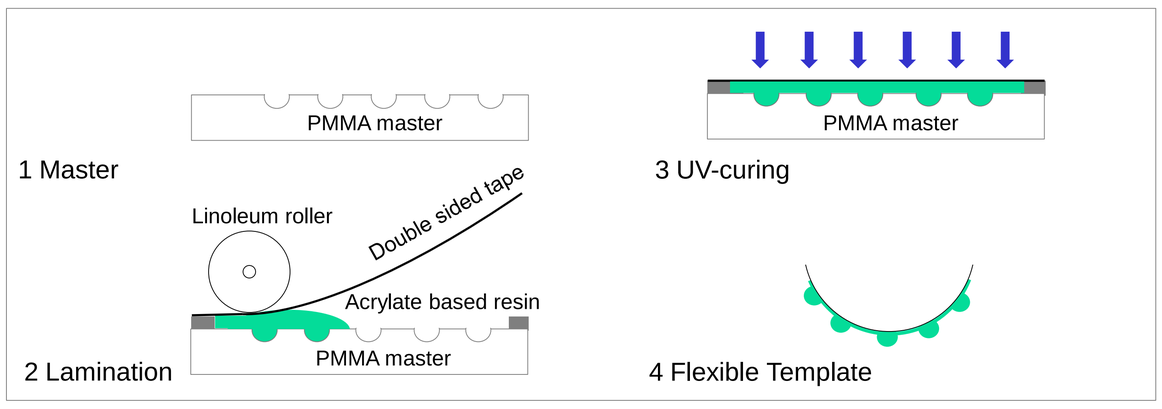

Fig. 2
Fabrication of a 150 µm thin and flexible template from a micro structured PMMA master.

3 Roll-to-plate approach

The core of the roll-to-plate fabrication unit is a transparent cylinder that houses a UV-source in its center. The self-adhesive transparent template can be mounted on the cylinder to pattern thiol-ene resin layers that are fed into the machine. When the template is in full contact with the resin, the resin is simultaneously cured in the nib. Lamination and bonding of microfluidic chips is achieved via a UV-activated bonding step utilizing the same roll-to-plate unit.

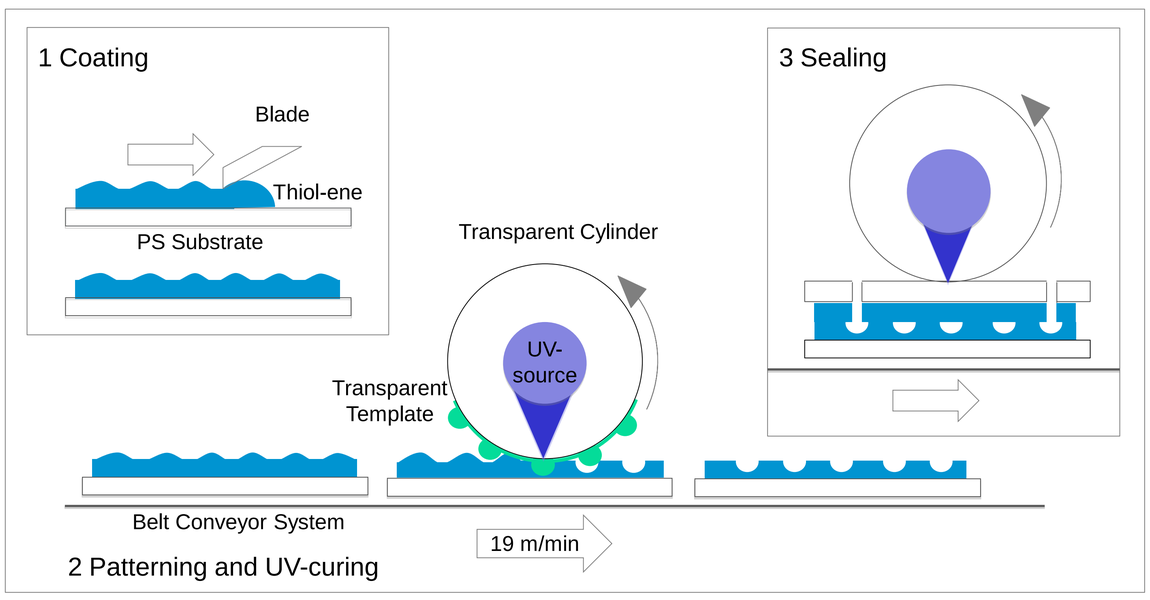

Fig. 4
1) Coating of polystyrene film via manual blade coating with a thin layer of thiol-ene. **2) Patterning and UV-curing** of the coated substrate with a modified offset printing machine (Stensborg A/S). **3) Sealing** of microfluidic structures with a blank thiol-ene film using the same setup.

4 Resin modifications

The viscosity and rheological behaviour of thiol-ene resins can be tuned with the addition of silica nanoparticles (Aerosil®) and a pre-polymerization to form oligomeric thiol-ene.

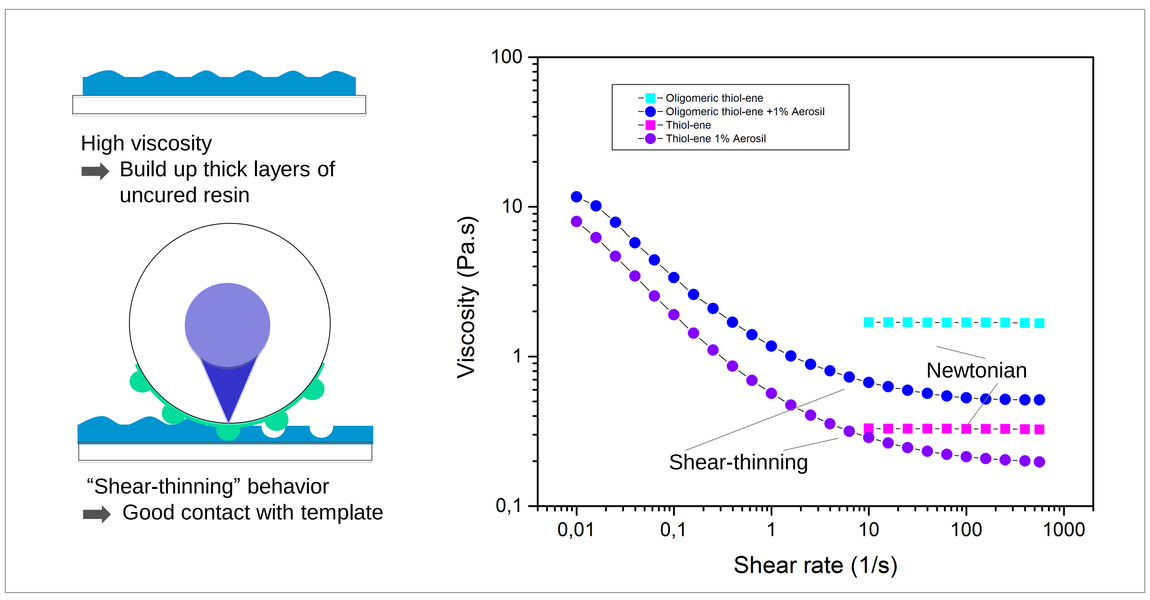

Fig. 5
Viscosity measurements of modified thiol-ene resins.

5 Results

Microfluidic chips for capillary electrophoresis were fabricated with the described roll-to-plate mechanism and tested for functionality and reproducibility.

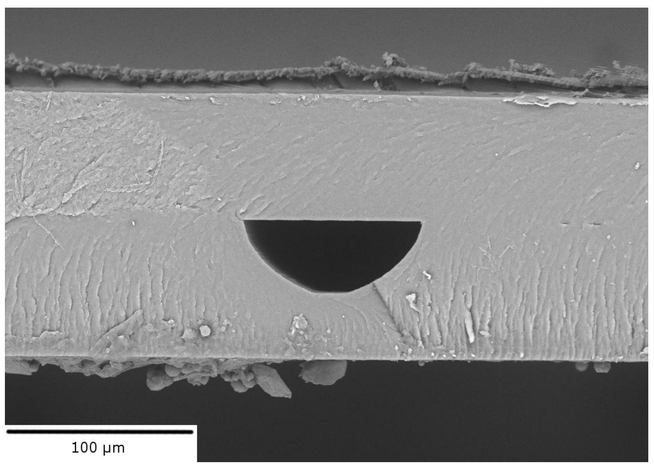

Fig. 6
SEM image of chip cross-section. Channel dimensions, W x H: 40 µm x 100 µm

Fig. 7
Roll-to-plate fabricated CE-chip with cross channel design.

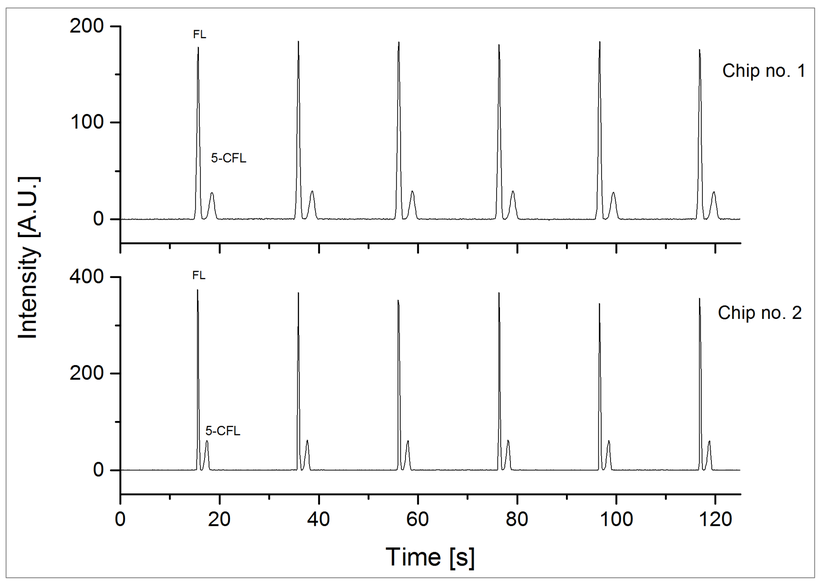

Fig. 8
Repeated separations of 10 µM fluorescein (FL) and 5 µM 5-carboxyfluorescein (5-CFL) in 10 mM bicine buffer (pH 9). Upper and lower electro-pherograms show separations performed on two different "randomly" selected chips from fabrication test runs. Time between injections: 20 s. Detection point 4.5 mm below injection cross.

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