Surface modification and fabrication technology for lab-on-a-chip devices in polymer materials

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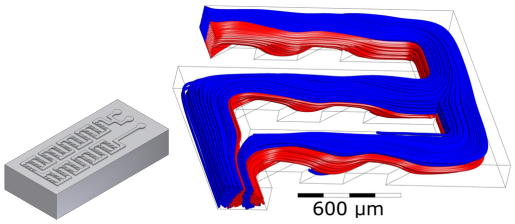
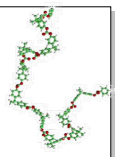
Introduction

- SINTEF is the largest independent research organisation in Scandinavia
- SINTEF is a complete supplier of the most relevant technologies for design and development of medical devices, and has experience in developing *in vitro* diagnostics platforms, as well as *in vivo* and *ex vivo* sensor systems (www.sintef.no/microsystems)
- This poster presents some of SINTEF's competence in surface chemistry and polymer technology, relevant for lab-on-a-chip devices



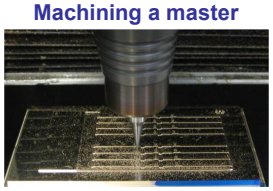
Novel micromixer concept – Good mixing performance, easy to fabricate (Tofteberg et al., *Microfluidics and Nanofluidics*, 2009)

Fabrication of lab-on-a-chip devices



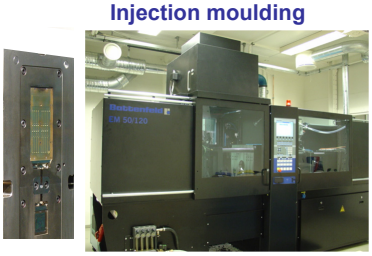
- **Thermoplastic polymer materials**
  - Great properties, low cost
  - A variety of polymers and grades with a range of property combinations:
    Permeability, auto-fluoroescence, optics, purity, impact toughness, ...
- **Injection moulding – Test series and mass production**
  - High precision and repeatability, low cost per unit
  - Many possibilities via mould design and process specialities

Machining a master



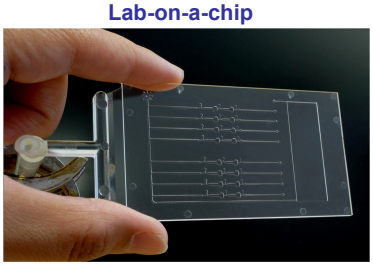
Milling of a brass master using a diamond tool (for low surface roughness). Sharp corners made by electrical discharge machining.

Injection moulding



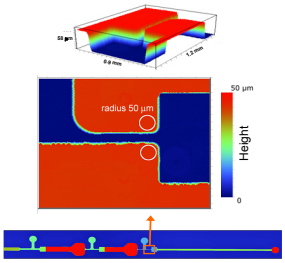
Left: Master mounted in a base mould. *Right*: SINTEF's injection moulding machine for micro-featured components.

Lab-on-a-chip

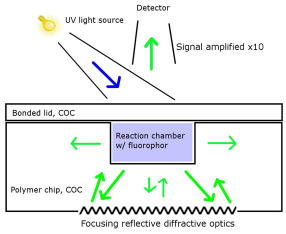


Lab-on-a-chip for real-time nucleic acid sequence based amplification (NASBA). This chip was developed by NorChip and SINTEF and injection-moulded by SINTEF. It is part of a general platform for detecting viruses and bacteria.

Characterisation



Geometrical details near capillary valve in injection-moulded chip characterised by white light interferometry.



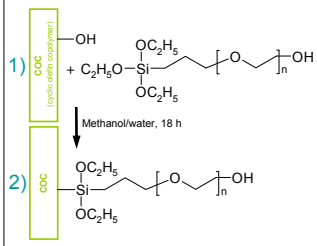
Chip with integrated optics

A schematical drawing of a lab-on-a-chip with integrated diffractive optics for increased optical sensitivity. Diffractive optics and microfluidics features are moulded in one step.

Chemical modification of surfaces

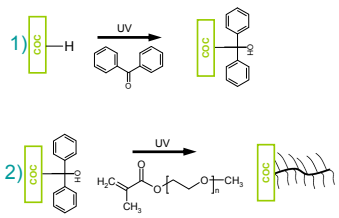
- **Preventing non-specific binding of proteins to channel walls**
  - Non-specific binding is a problem in many microfluidics applications. It is frequently addressed for sensors when analysing real samples containing a plethora of unknown interfering samples.

Plasma treatment and silanisation



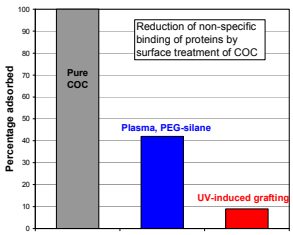
1) Hydroxyl groups introduced by oxygen plasma treatment.
2) PEG chains grafted to the surface using a PEG-silane.

UV-induced grafting



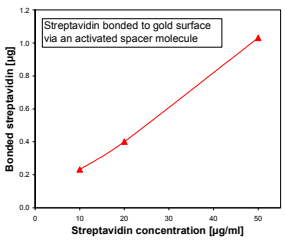
Two-step UV irradiation method:
1) Initiator (benzophenone) introduced.
2) Polymerisation of PEG methacrylate initiated at grafting sites.

The diagram shows that protein adsorption can be reduced. With UV-induced grafting, in particular, very low non-specific binding can be obtained.



- **Introducing receptor molecules at sensor surfaces**
  - Biosensors utilise nature's ability to produce different specific binding molecules and receptors, such as anti-bodies, streptavidin, and DNA or RNA strands.
  - Biospecific receptors are chemically bonded to the surface via an activation step.
  - In lab-on-a-chip devices, receptor molecules can be bonded to specific spots, e.g. gold-coated sensor surfaces

The diagram shows results for a receptor (streptavidin) immobilised specifically to a gold surface. The amount of bonded streptavidin is quantified with a radioactive tracer.



Acknowledgements
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