Advanced surface modification by triggered assembly

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Outline

- About Surfix
- Triggered vs. self-assembly
- Material-selective surface modification
  - biosensor functionalization
- Local surface modification
  - patterned coatings for biochips
- Summary and conclusions
About Surfix

Who we are

Founded in 2011
Spin-off Wageningen University
  >15 years of research
  >100 scientific publications
8 employees

Expertise in:
- surface chemistry
- surface characterization
- organic chemistry
- biochemistry
- physical chemistry
About Surfix

What drives us

World-changing micro & nanotechnologies

Control over surface properties is essential

New and advanced surface modification

Make the difference

Improve performance

Create new opportunities

Generate breakthroughs
About Surfix

What we offer

Current activities
- custom coating development
- surface characterization
- consultancy

Way of working
- R&D contract / partnership
- low volume production
- technology transfer

Application examples

Biosensors

Microfluidics

Microsieves

AFM cantilevers
About Surfix

What we offer

State of the art surface modification

New and advanced surface modification

Spontaneous self-assembly process

Triggered assembly process

Uniform modification

Material-selective modification

Local modification
Triggered vs. self-assembly

Self-assembly
- noble metals
- easy to prepare
- well studied
- limited stability

- oxides
- poor reproducibility
- self-reactive
- limited stability

- metal oxides
- easy to prepare
- not self-reactive
- highly stable

thiols silanes phosphonates

Triggered assembly
- various materials, e.g.:
  Si, SiO₂, Si₃N₄, SiC, Al₂O₃, …
- heat or light-triggered
- highly stable
- proprietary Surfix technology

alkenes more to come…

Benefits
- better reproducibility
- no polymerization or aggregation
- no clogging of channels or pores
- precursor can be reused
- advanced surface modification
  - material-selective
  - local

more to come…
Biosensor functionalization

- micro ring resonator, Si$_3$N$_4$ waveguide surrounded by SiO$_2$
- waveguide occupies <1% of surface area
- analyte binding on >99% of the sensor is undetected
- improved LoD by material-selective biofunctionalization
Material-selective surface modification

Biosensor functionalization

\[ \text{SiO}_2 \rightarrow \text{Si}_3\text{N}_4 \rightarrow \text{SiO}_2 \]

Binding Energy (eV)

\[ \text{SiO}_2 \rightarrow \text{Si}_3\text{N}_4 \rightarrow \text{SiO}_2 \]

Binding Energy (eV)

Material-selective surface modification

Biosensor functionalization
Material-selective surface modification

Biosensor functionalization

![Diagram of material layers](image)

![Graphs showing binding energy](image)
Material-selective surface modification

Biosensor functionalization

- binding of fluorescently labelled biomolecule
- fluorescence pattern demonstrates concentration of biomolecules on waveguide
Local surface modification

Patterned coatings

- Light-triggered surface reaction enables patterning using a photomask
- Resistless, single-step process
- High chemical contrast
- High spatial resolution (<10 μm)
- Secondary modification and/or backfilling of uncoated area possible
Local surface modification

Hydrophobic/hydrophilic patterns

condensation pattern

wafer-scale patterning

10 µm hydrophilic dots
Local surface modification

Superhydrophobic/philic patterns

<table>
<thead>
<tr>
<th>superhydrophilic/-phobic channel</th>
<th>static water contact angle (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>optical transparency is retained!</td>
<td>light dark</td>
</tr>
<tr>
<td>rough glass</td>
<td>&gt;150 &lt;10</td>
</tr>
<tr>
<td>advancing</td>
<td>receding</td>
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</tbody>
</table>
Local surface modification

Patterned coatings for biochips

- multifunctional (micro)patterned surfaces offer exciting opportunities
- hydrophilic/hydrophobic: liquid confinement and direction (arrays, microfluidics)
- cytophilic/cytophobic: single-cell studies, organ-on-a-chip
- biorecognition/antifouling: biosensing
Summary and conclusions

- Advanced micro- and nanotechnologies require advanced surface modification
- Surfix technology based on triggered assembly enables
  - material-selective surface modification
  - local surface modification
- Life science application examples
  - biosensors
  - biochips
For more information and demonstrators:
visit us at booth 12
Acknowledgment