

## Bio-Chemical Functionalisation of Silicon Surfaces

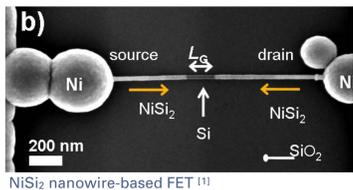
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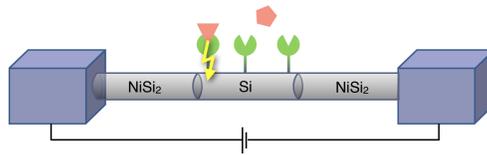
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### Introduction



#### Biosensors

- nanowire-based sensor
- inorganic surface: silicon
- biomolecules for detection of targets



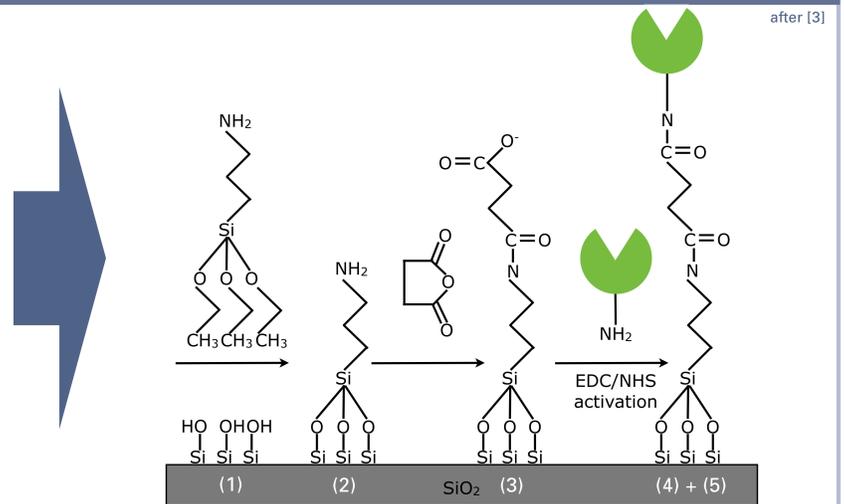
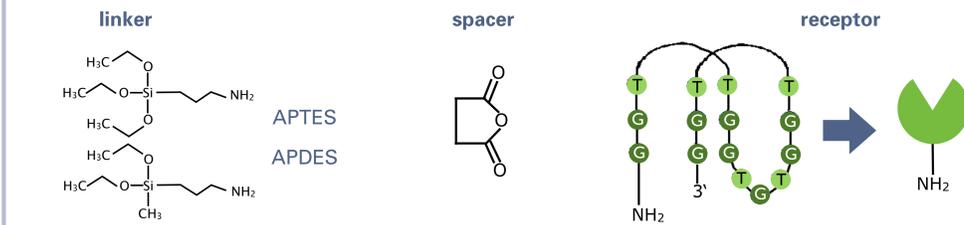
**Aim: study surface functionalisation**

➔ from wafer to nanowire

➔ immobilisation of biomolecules

### Strategy & Experiment

	substance	function
(1) SiO <sub>2</sub> surface	organic solvents and plasma treatment	cleaning and providing of hydroxy end groups
(2) linker	organosilanes: (3-aminopropyl)triethoxysilane: APTES, 3-aminopropyl(diethoxy)methylsilane: APDES	providing of amino end groups
(3) spacer	succinic anhydride	providing of carboxy end groups
(4) zero-length crosslinker	EDC/NHS	activation of carboxy group for amide bond formation
(5) receptor	anti-Thrombin aptamer (ssDNA strand) 5'-NH <sub>2</sub> -GGTTGGTGGTGGTGG-3' <sup>[2]</sup>	3D folding for Thrombin detection



### Results - Reactive Groups

#### Static contact angle, labelling with charged gold nanoparticles (AuNPs)

investigation of the reactive surface groups to show the successful binding of molecules to the surface

static contact angle:

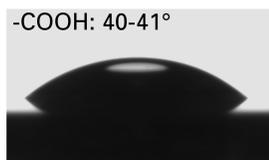
- the binding of -NH<sub>2</sub>-terminated molecules increases the CA of ddH<sub>2</sub>O on the substrate from <10° to appr. 65°
- -COOH-terminated surface after succinic anhydride binding: reduced CA of appr. 40°



bare Si



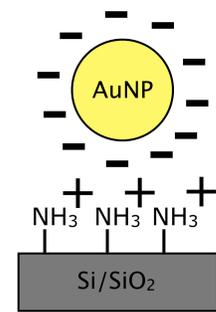
organosilane (APTES, APDES): amino-terminated surface



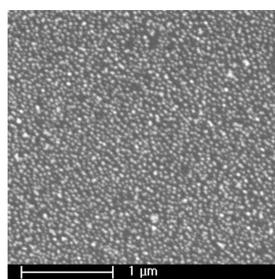
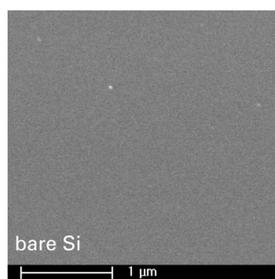
succinic anhydride: carboxy-terminated surface

#### AuNP labelling

- model



- successful labelling of positively charged surfaces with negatively charged AuNPs
- no bound NPs on bare Si

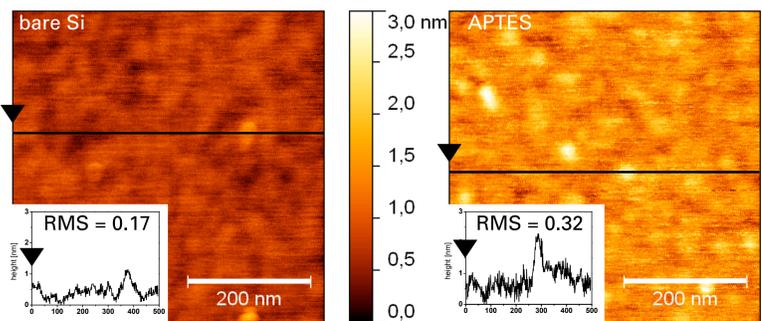


organosilane (APTES) + AuNPs: amino-terminated surface

### Results - Monolayer

#### AFM topography, ellipsometry

Monolayer formation of organosilanes is proven by AFM and ellipsometer analysis



Ellipsometric thickness

$d_{SiO_2} = 2.1 \text{ nm}$

$d_{APTES} \approx 1 \text{ nm}$

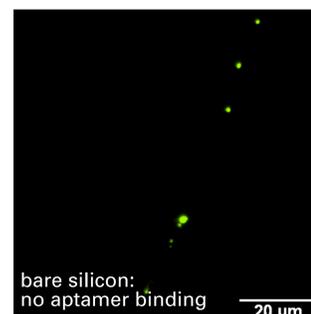
### Results - Receptor Binding

#### Fluorescence microscopy

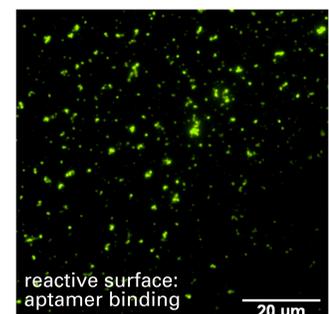
optical detection of anti-Thrombin aptamer bound to reactive carboxy surface with FAM\*-modified aptamer

- no fluorescence on non-functionalised Si wafer (left)
- **successful aptamer binding** to functionalised reactive surface (right: high density of fluorescent dots)

\*FAM - carboxy-fluorescein dye



bare silicon: no aptamer binding



reactive surface: aptamer binding

### Acknowledgements

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### References

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- [3] G.T. Hermanson (ed.), Bioconjugate Techniques, Academic Press, 2008