

Magnetically Enhanced Microflow Cytometer for Bead- and Cell-based Immunoaffinity Measurements in Whole Blood Samples



Scientific thesis for the attainment of the academic degree
Master of Science (M.Sc.)
of the Department of Electrical and Computer Engineering
at the Technical University of Munich.

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1. Introduction and Motivation

2. Theoretical Prerequisites

2.1. Microfluidics

conservation of mass, momentum reynolds number

2.1.1. Flow Field inside Microchannels

Navier-Stokes-Approximation for Hagen-Poiseuille

2.1.2. Particles in Microfluidics

Stokes Drag Force Gravity Magnetic Force Friction Interface-Forces

2.1.3. •

2.2. Surface Chemistry

2.2.1. Carbodiimide Crosslinker Chemistry

EDC-NHS-Activation sulfo-NHS vs. NHS

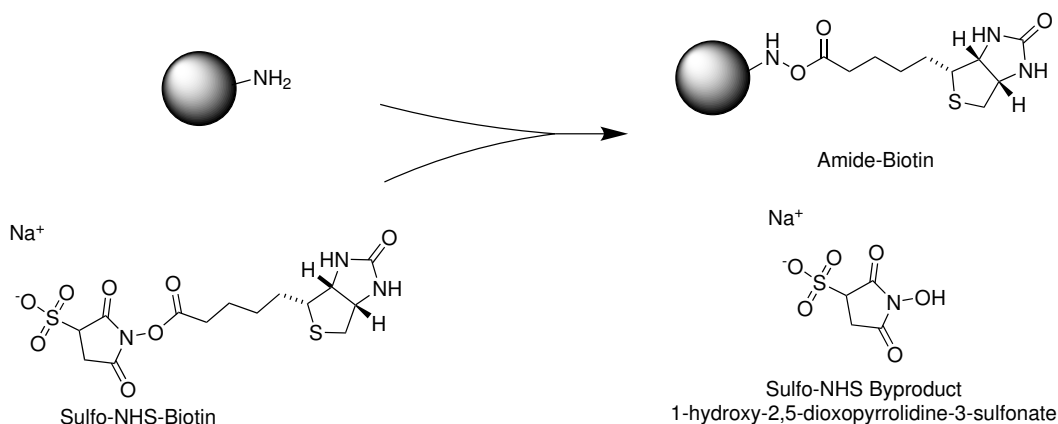


Figure 1 TestSvg

2.3. MRCyte

Short intro over MRCyte Foto of setup with arrows to necessary parts Microscope

Stages PEEK holder Helmholtz coils Kepco MFLI DAQ

2.3.1. Focusing Structures

test,test

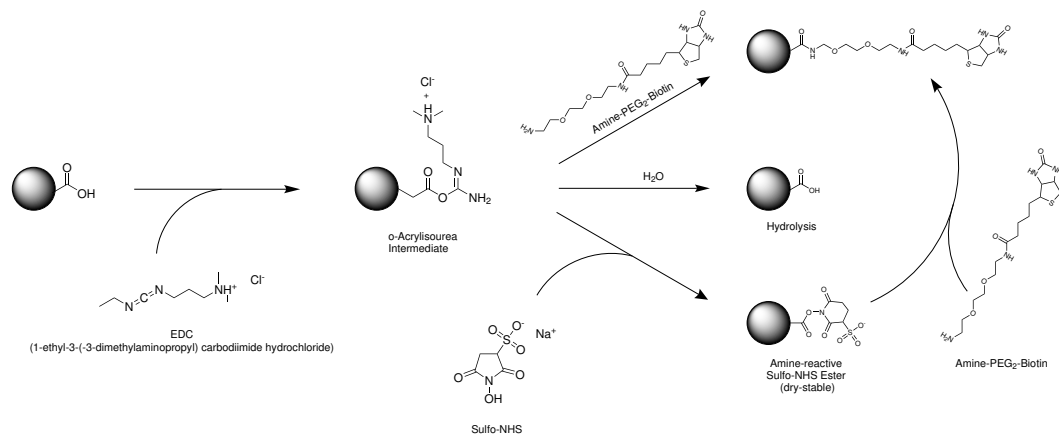


Figure 2 TestSvg

2.3.2. GMR

Different produced GMR stacks Wheatstone Bridge setup Magnet alignment

Hysteresis Alignment

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2.3.3. Electrical Circuit

Ground PCB Stacked PCBs with spacer

2.3.4. Electronic Readout

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Single GMR

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Dual GMR

one MFLI supplies both at same frequency. Aux Trigger tested, but no advantage.

3. Materials and Methods

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4. Results

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4.1. Signal Similarity For Cells With Varying Bead Coverages

Cross-Correlation between single dipole with sum magnetic moment and surface covered with randomly distributed magnetic particles

4.1.1. •

4.2. Reference Bead Surface Functionalization

4.2.1. Amine-Surface Biotinylation

Magnetic Polystyrene Bead

Non-Magnetic Polystyrene Bead

4.2.2. Carboxy-Surface Biotinylation

4.3. Protein Immobilization On The Microfluidic Channel

Bottom

4.3.1. Physisorption

4.3.2. Covalent Attachment

Plasma-Based Approach

Water-Based Approach

1:1

5. Discussion

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6. Outlook

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Statement

I declare that I have authored this thesis independently, that I have not used other than the declared sources / resources, and that I have explicitly marked all material which has been quoted either literally or by content from the used sources.

Munich, December 4th, 2020, Signature