Protein Adsorption to Biomaterials

Radioactive Labelling Analysis & Atomic Force Microscopy

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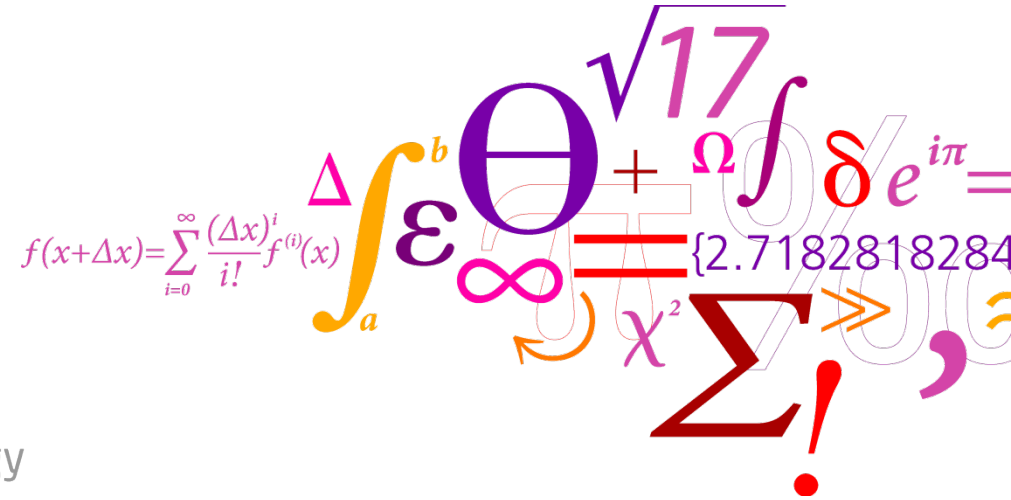


DTU Nanotech
Department of Micro- and Nanotechnology

Background

Biomaterials

Materials that interact with a biological system

Materials that are part of implants, drug delivery systems, biomedical equipment, disposable devices, biosensors etc.

Protein adsorption

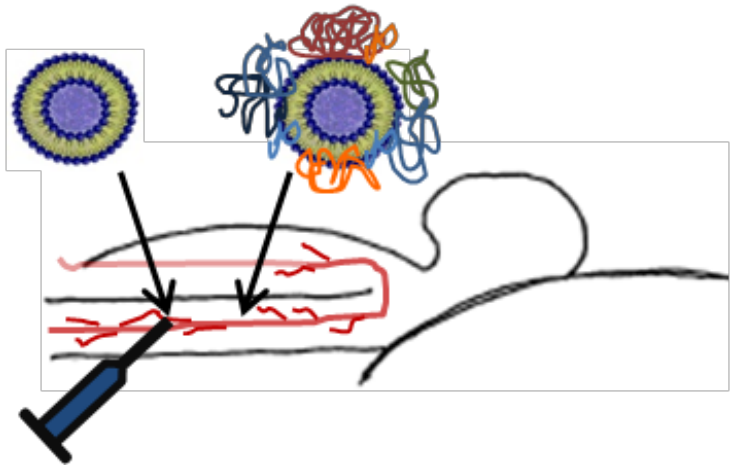
First step in a cascade of events that eventually can result in non-wanted responses

Influence on functionality of designed systems

Controlling protein adsorption

Manipulating with response

Surface characteristics



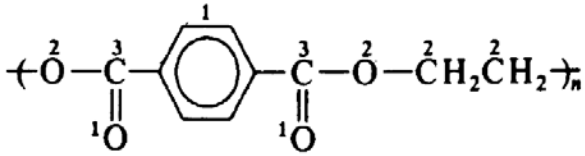
Blood protein adsorption onto polymer materials

Albumin (67 kDa), IgG (150 kDa) & fibrinogen (340 kDa)

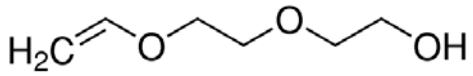
Radioactive multi-label system & AFM

Background

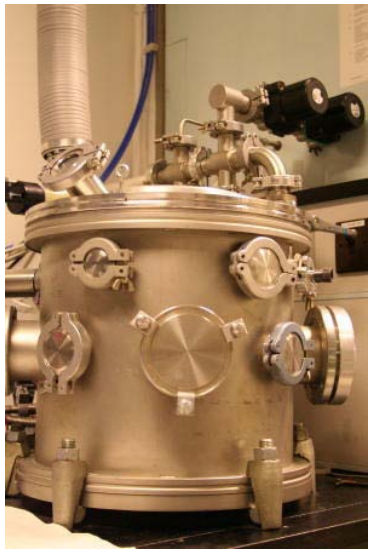
PET (polyethylene terephthalate)



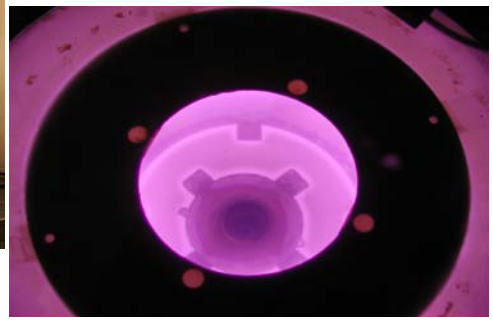
DEGVE (diethylene glycol vinyl ether)

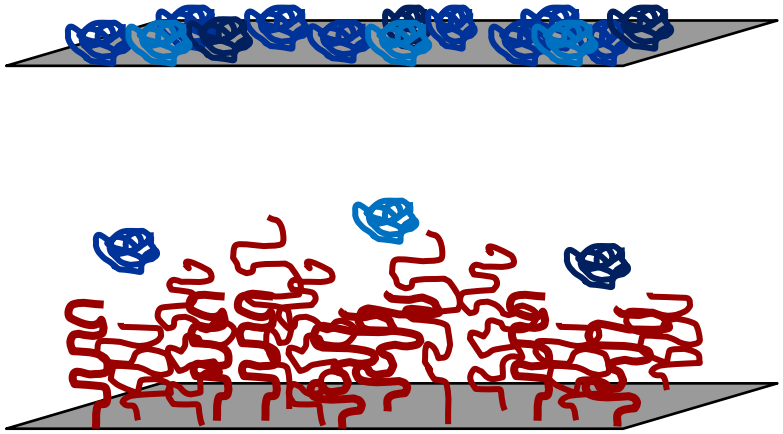


Plasma polymerisation



Argon pre-treatment
Plasma copolymerisation
Working pressure 5-50 Pa
2 phase 50 Hz AC power supply
100 Hz pulsed plasma current
Energy ~ 1-5 Watt

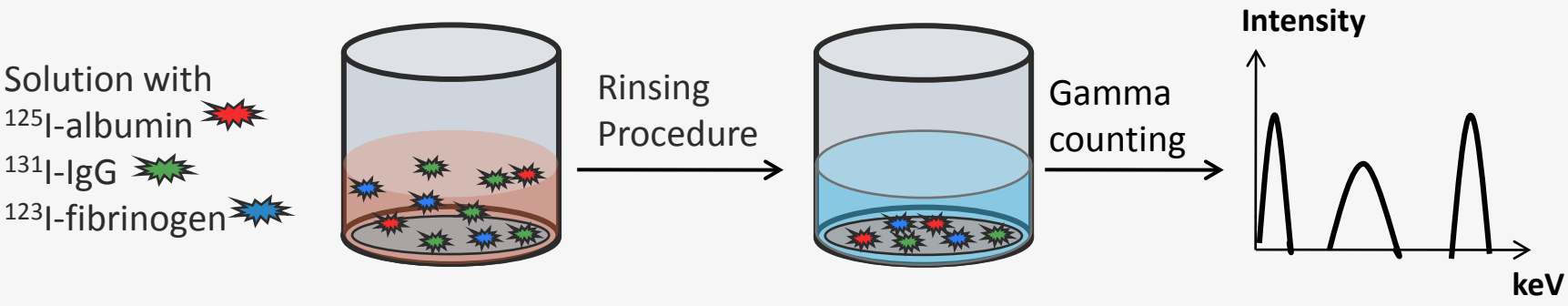




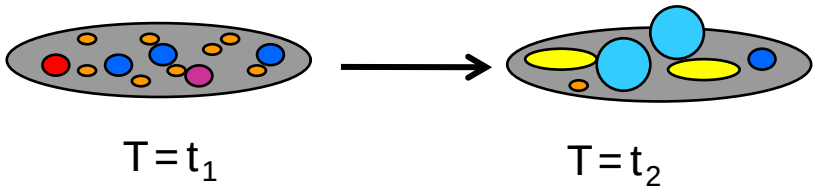
M. Holmberg et al., J Mater Sci: Mater Med. 19 (2008), 80

Radioactive Labelling

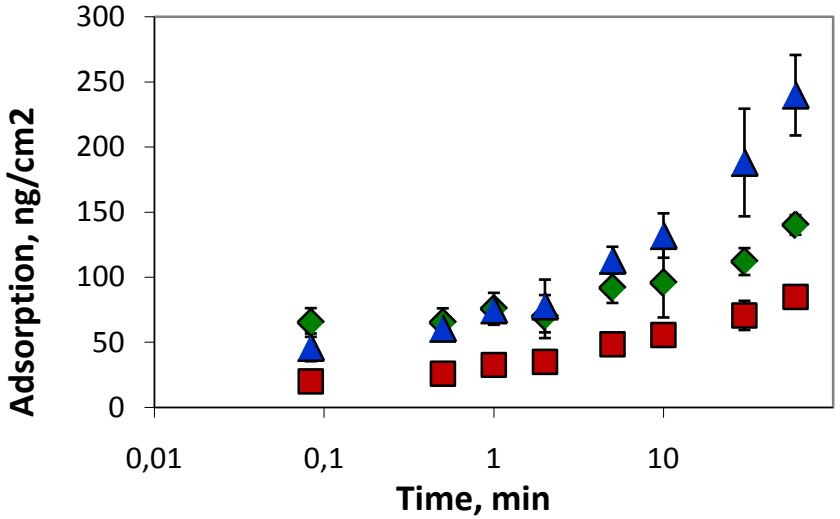
Quantitative Protein Adsorption Analysis



Quantitative technique for Competitive Adsorption from Complex Solutions

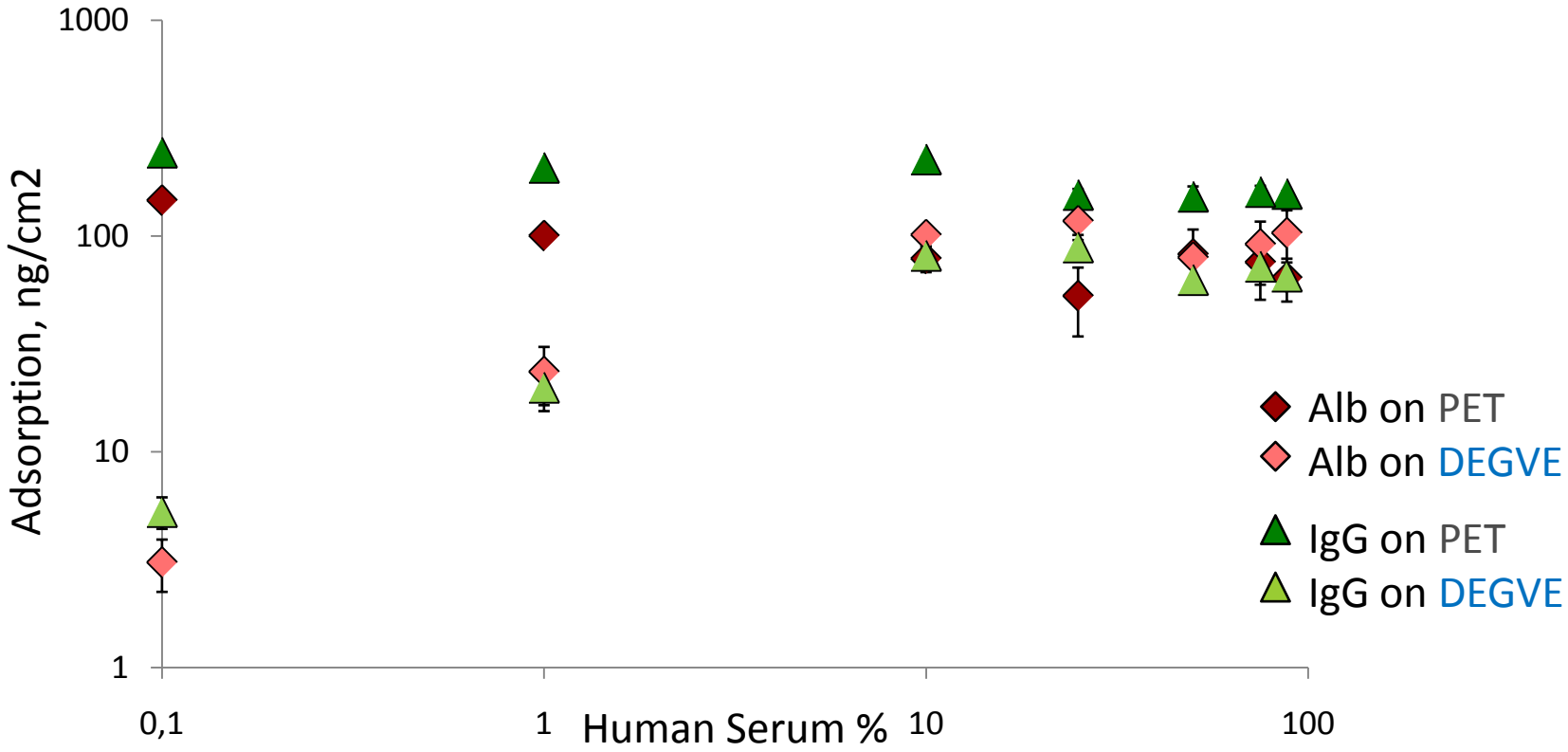


Function of time, concentration, surface characteristics etc.



Competitive Protein Adsorption

Alb & IgG adsorption onto PET & DEGVE (1 h & 24 h)



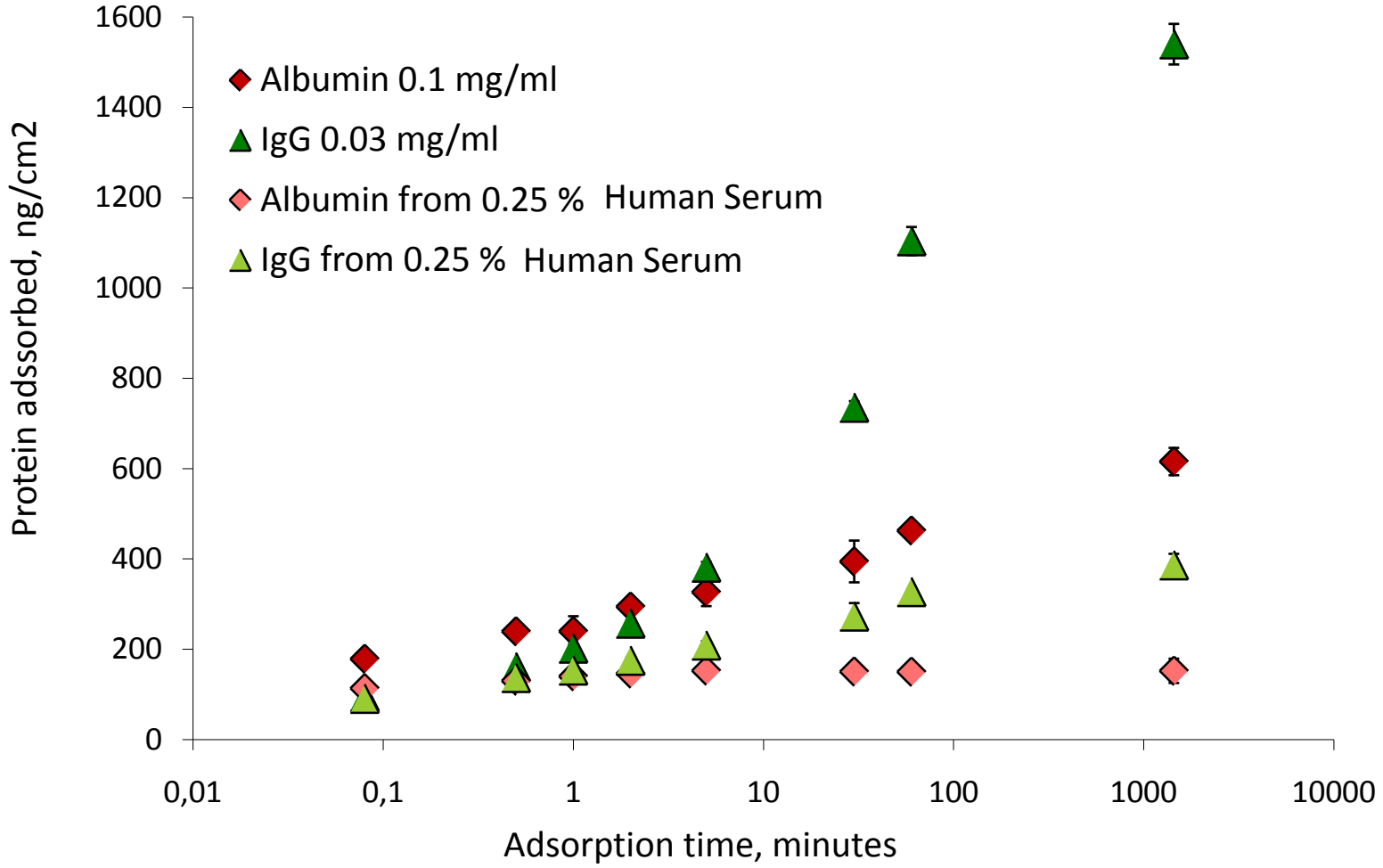
PET – decrease with increased human serum %

DEGVE – increase with human serum %

M. Holmberg et al., Langmuir 26 (2010), 938

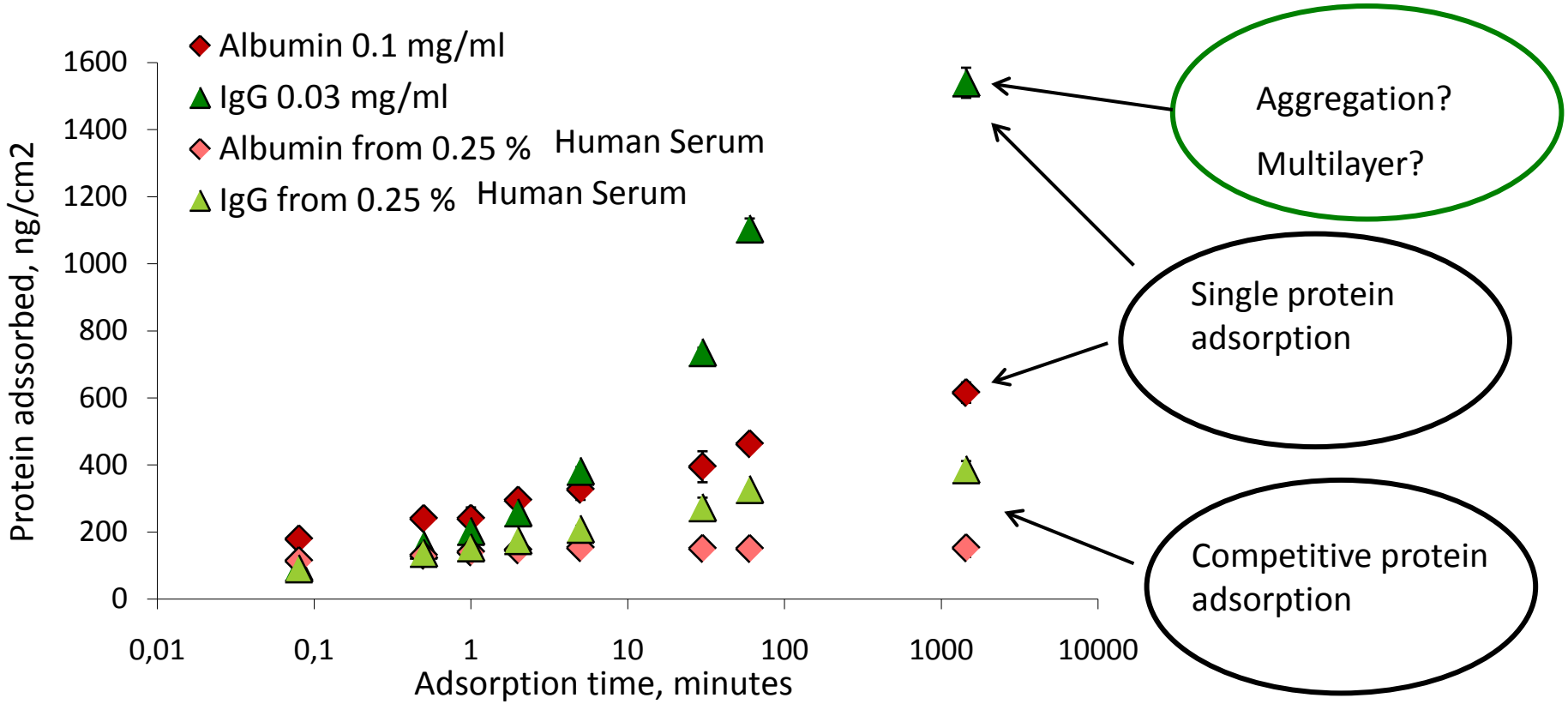
Alb & IgG adsorption onto PET

Single protein adsorption versus Competitive protein adsorption onto PET



M. Holmberg et al., Langmuir 25 (2009), 2081

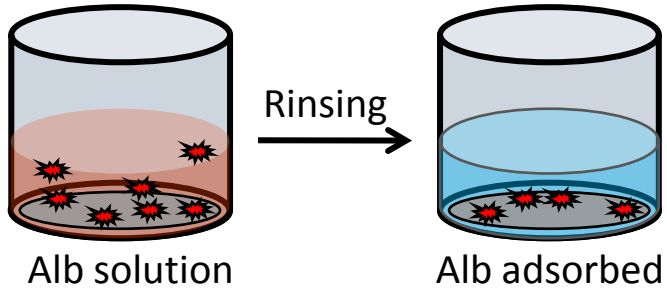
Alb & IgG adsorption onto PET

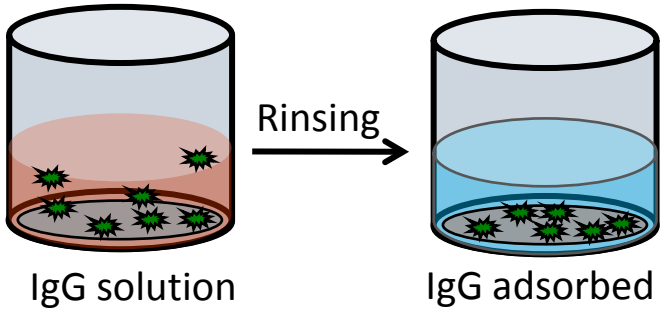


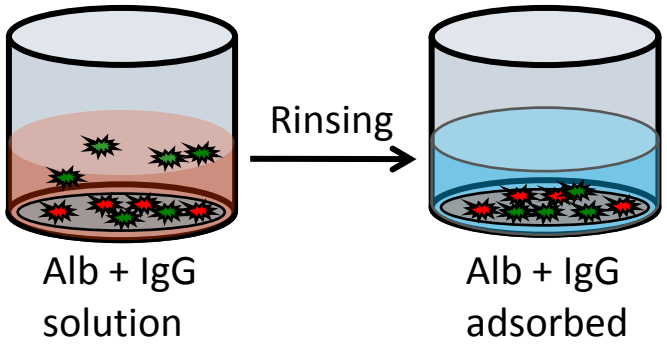
Influence from presence of other proteins

Specific interaction between protein and surface

Alb & IgG adsorption onto PET & DEGVE







Adsorption of Alb & IgG onto PET & DEGVE

10 mg/ml Alb & 3 mg/ml IgG (25 % human serum)

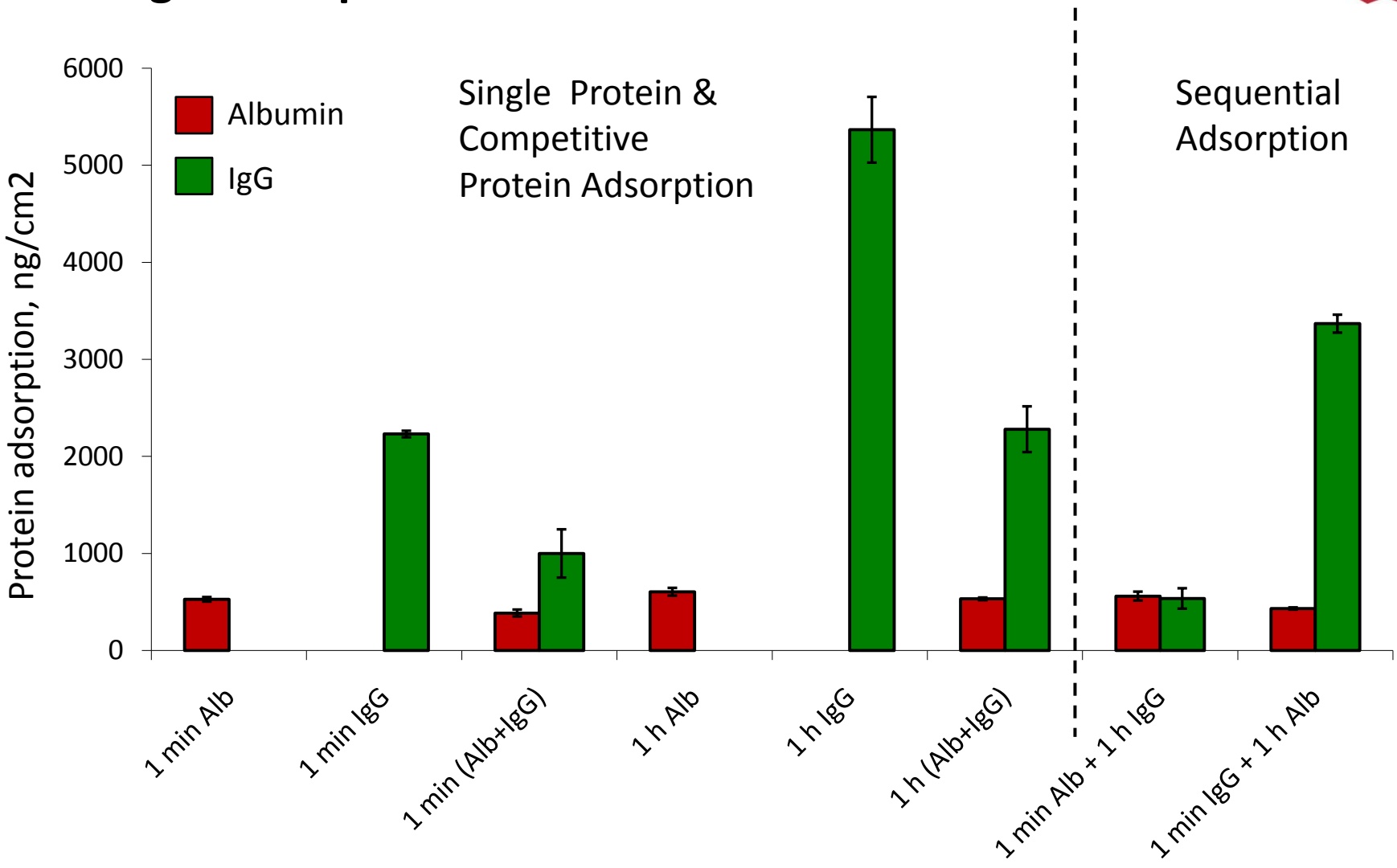
Different adsorption times (1 min versus 1 h)

Single protein adsorption

Competitive protein adsorption

Sequential protein adsorption

Alb & IgG adsorption onto PET



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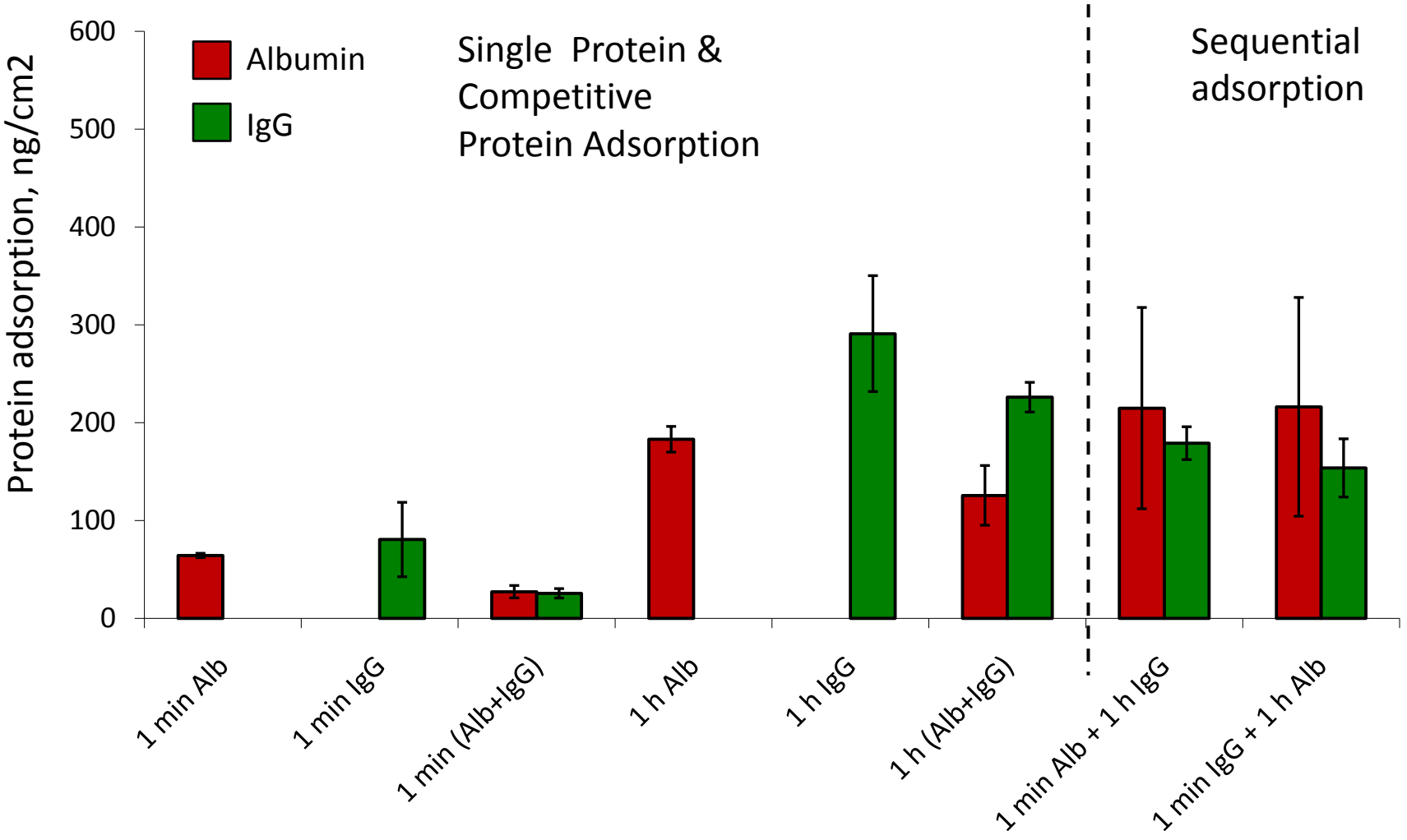
Alb & IgG adsorption onto DEGVE



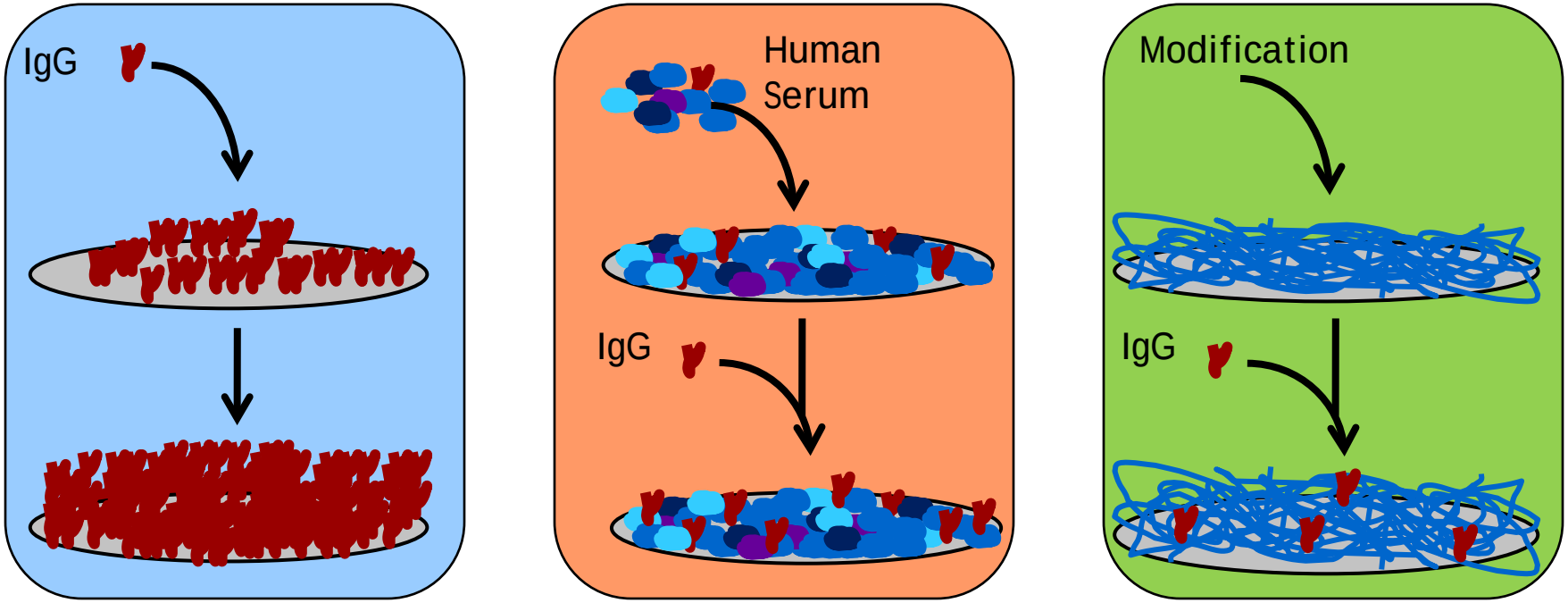
M. Holmberg et al., Langmuir 25 (2009), 2081

Conclusions – IgG adsorption

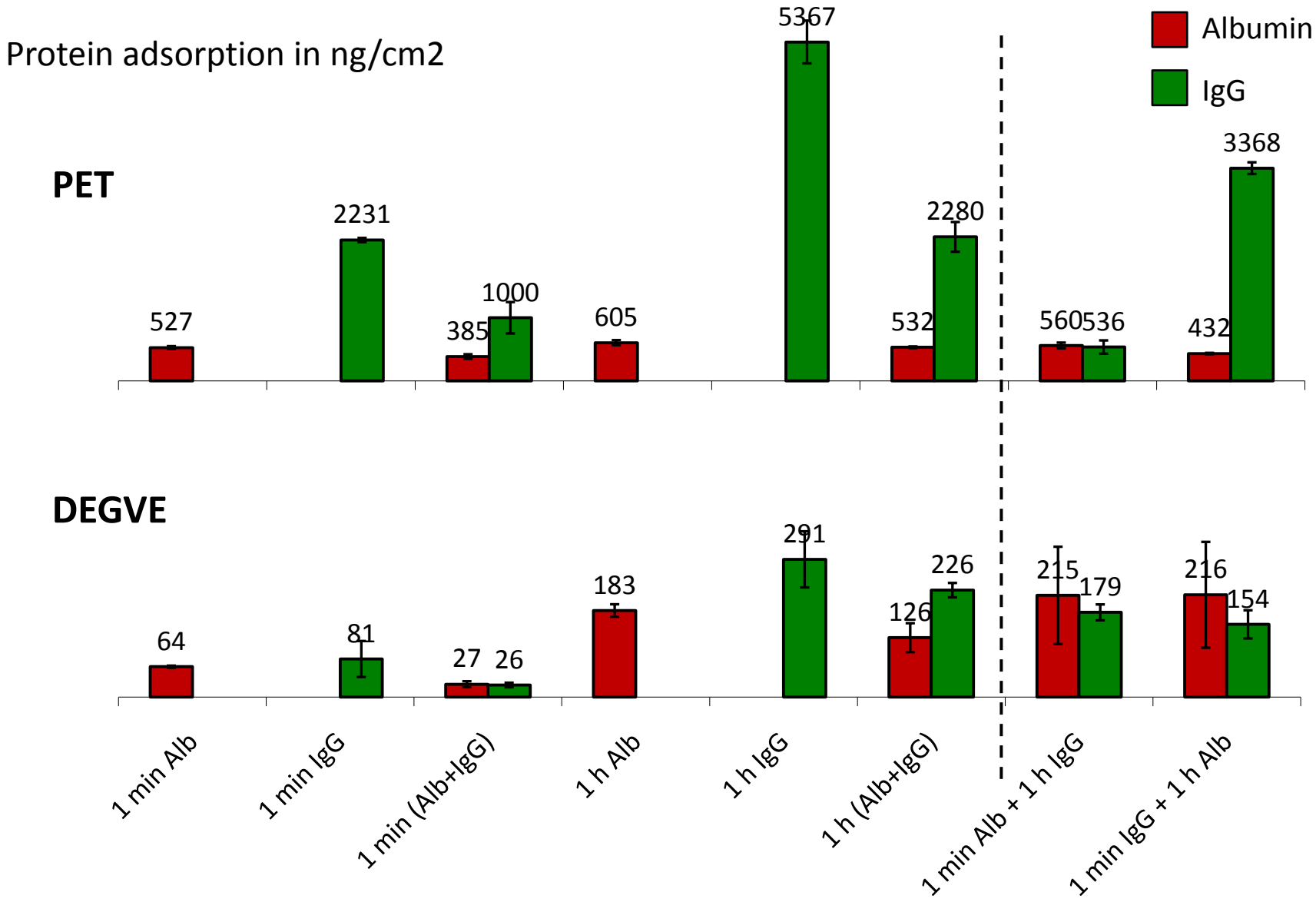
Specific protein-surface interaction – *surface induced protein aggregation*

Influence from presence of other proteins – *competition and blocking of surfaces*

Non-fouling characteristics of DEGVE – *lower adsorption*

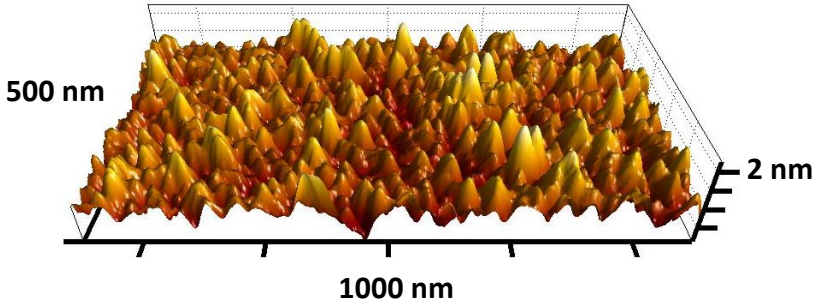


Alb & IgG adsorption onto PET and DEGVE

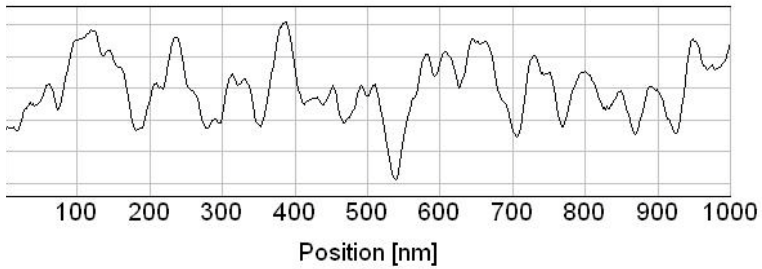


Atomic Force Microscopy

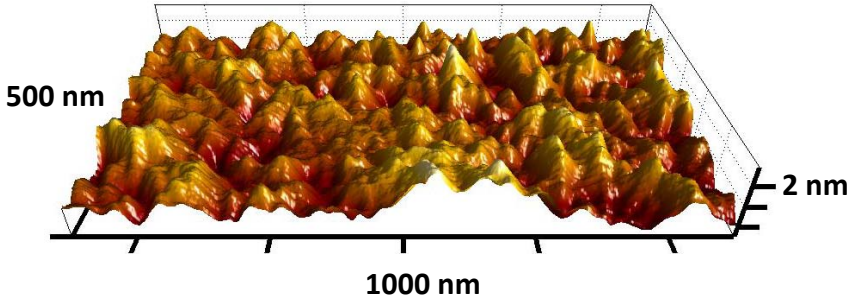
Tapping Mode in air, **PET**



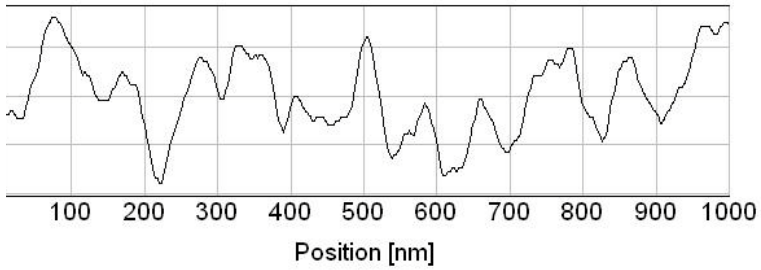
Sq = 0.995 nm



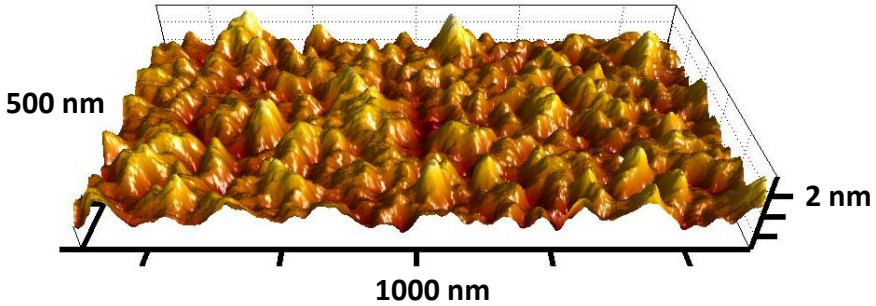
Tapping Mode in air, **PET + 3 mg/ml IgG**



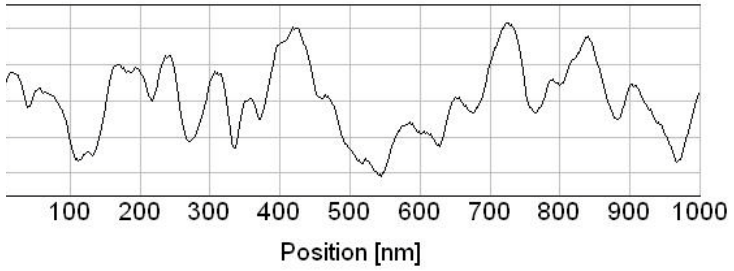
Sq = 0.980 nm



Tapping Mode, **PET + 10 mg/ml Alb**



Sq = 0.874 nm

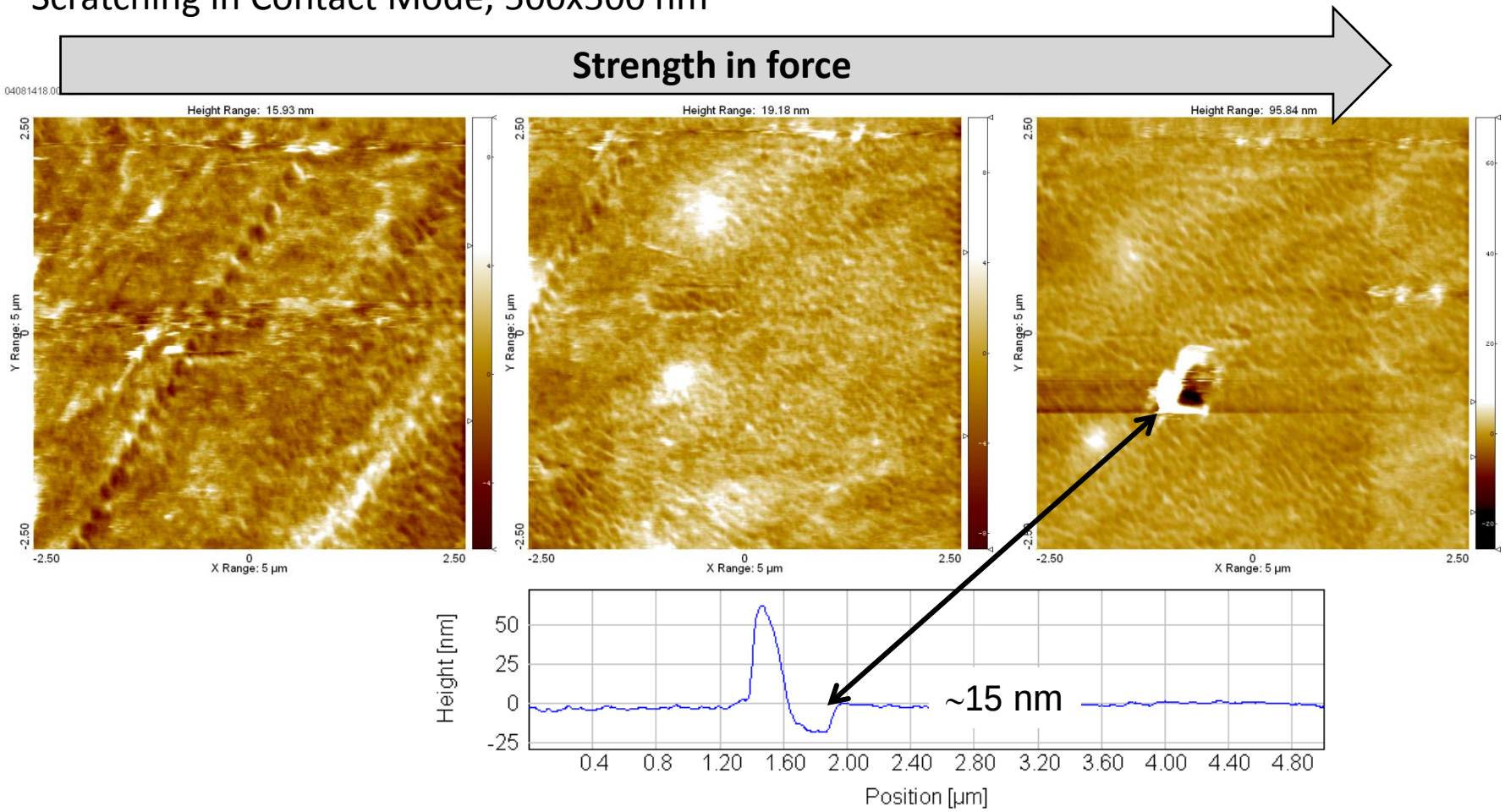


Atomic Force Microscopy

Closed system using a liquid cell and o-ring

PET + 10 mg/ml albumin, Imaging in Tapping Mode, 5x5 µm

Scratching in Contact Mode, 500x500 nm



Summary

Radioactive Multi-Labelling - quantitative analysis of competitive protein adsorption from of complex solutions

Evaluating Biomaterials

- Characteristics of protein and surface
- Difference in adsorption patterns
- Specific interaction between protein and surface
- Presence of other proteins

Understanding the protein-surface interaction

Design of biomaterials and devices

Acknowledgement

Xiaolin Hou

Radiation Research Division, Risø DTU

Lene Hubert, Lotte Nielsen & Sokol Ndoni

DTU Nanotech, DTU

CBIO group at DTU Nanotech

Group leader Thomas Andresen

Jørgen Garnæs

DFM – Danish Fundamental Metrology

Nils Berg Madsen

Novo Nordisk A/S

Hanne Everland

Coloplast A/S

Lydia Dahl Clausen

Radiometer Medical Aps