LSPR TRANSDUCERS FOR SENSING AND IMAGING OF PROTEIN-CARBOHYDRATE INTERACTIONS

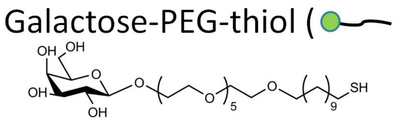
Alexander B. Tesler,[1] Giuliano Bellapadrona,[1] Dan Grünstein,[2] Laila Hossain,[2]
Kikkeri Raghavendra,[2] Peter H. Seeberger,[2] Alexander Vaskevich,[1] Israel Rubinstein[1]
[1]*Dept. Of Materials & Interfaces, Weizmann Institute of Science, Rehovot, Israel*
[2]*Max-Planck-Institute of Colloids and Interfaces, Free University, Berlin, Germany*

Introduction

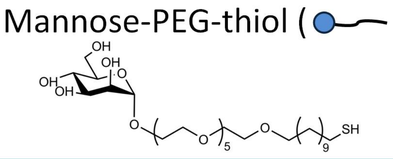
Ultrathin evaporated/annealed gold island films combined with synthetically-modified carbohydrates are used to develop effective localized surface plasmon resonance (LSPR) transducers for monitoring and imaging of protein-carbohydrate interactions. Specific recognition of mannose by Concanavalin A (Con A) is used as a model system in stationary and dynamic configurations.

Materials

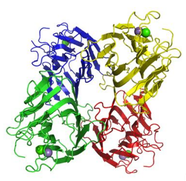
Galactose-PEG-thiol ( )



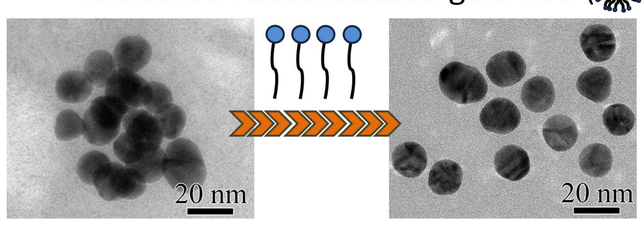
Mannose-PEG-thiol ( )



Con A ( )

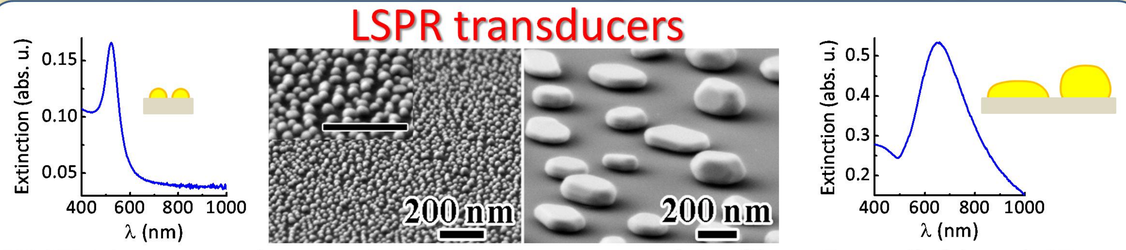


Mannose-functionalized gold NPs ( )



Citrate-stabilized Au NPs were functionalized with Mannose-PEG-thiol.

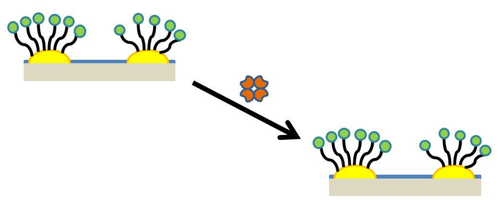
LSPR transducers



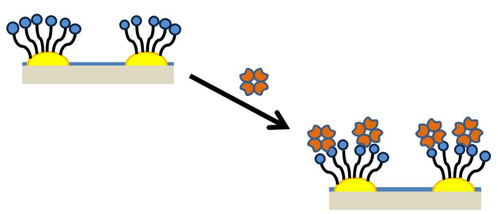
HRSEM images and transmission UV-vis spectra of Au films, 5 nm (**left**) and 15 nm (**right**) (nominal thicknesses), evaporated on bare glass and annealed 10 h at 570 °C.

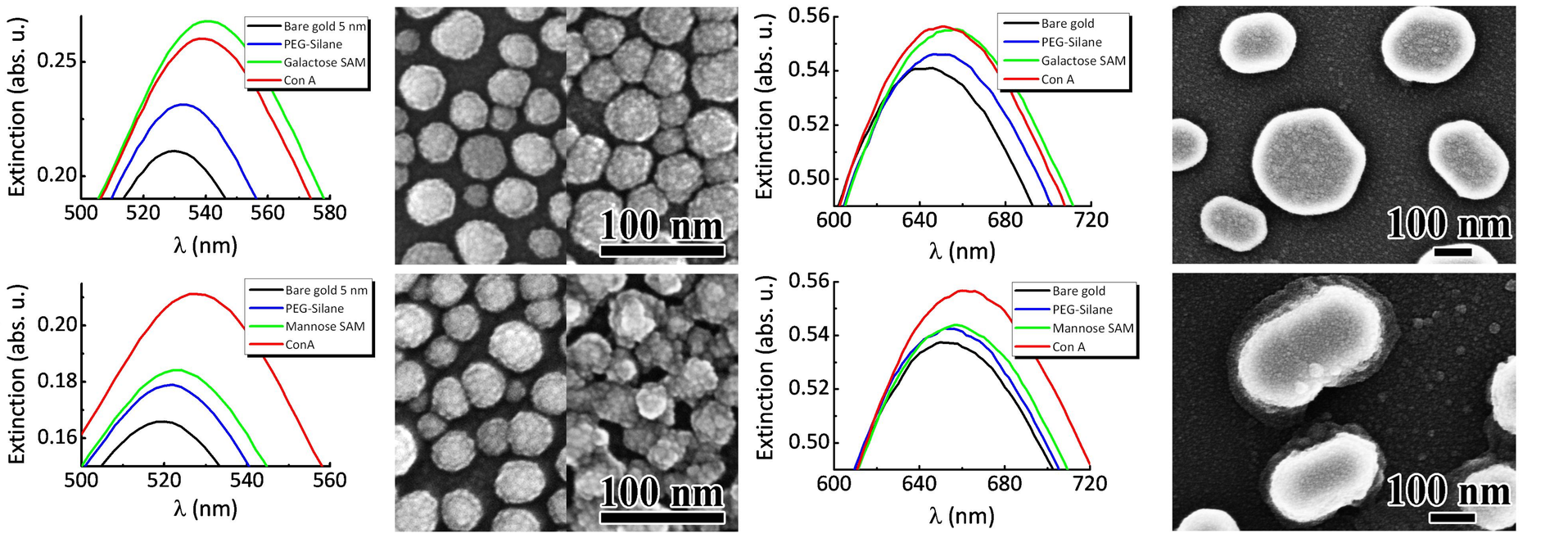
Protein (Con A) recognition using carbohydrate-modified Au island transducers

Galactose-PEG-thiol SAM:
No binding of Con A



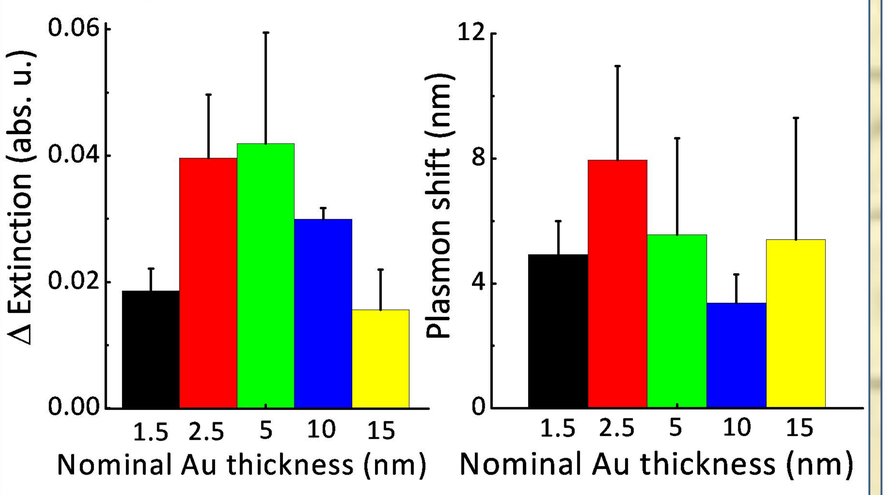
Mannose-PEG-thiol SAM:
Recognition and binding of Con A





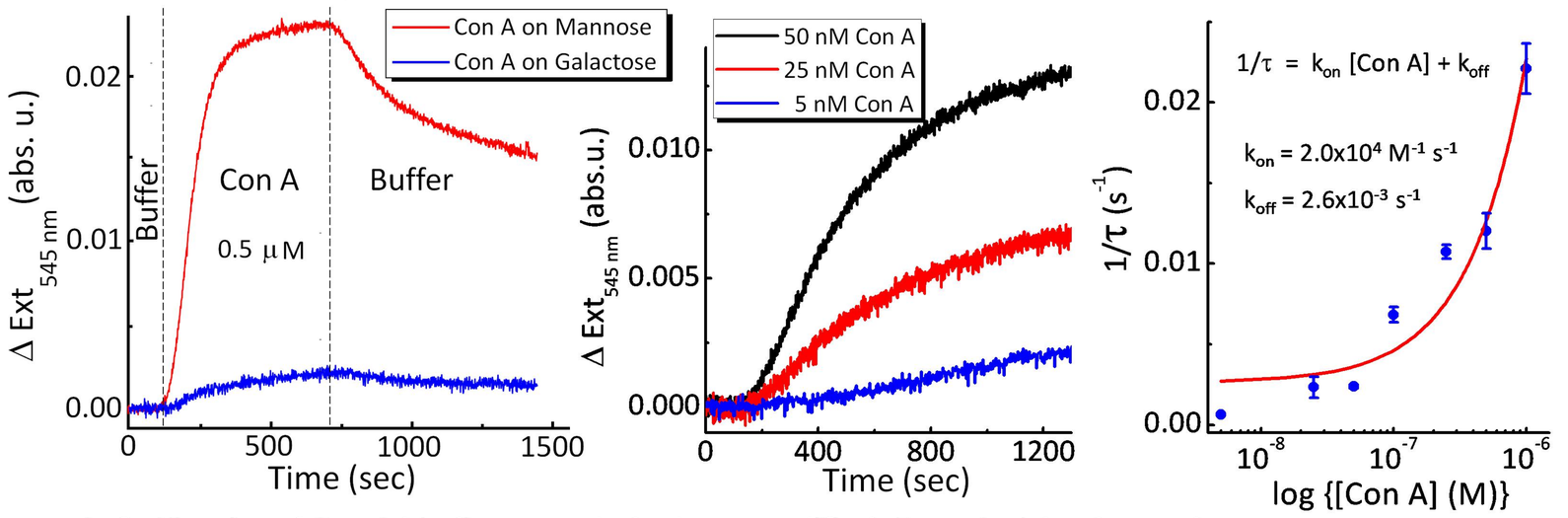
Schematic illustration of the sensing process, respective LSPR spectra, and HRSEM images (after last step; covered with 3 nm Cr) for 5 nm (**left**, without / with fixation) and 15 nm (**right**, no fixation) Au island transducers, covered with Mannose and Galactose SAMs. [Con A] = 1 μM. Note the visible protein layer in bottom images.

Optimization of LSPR transducers



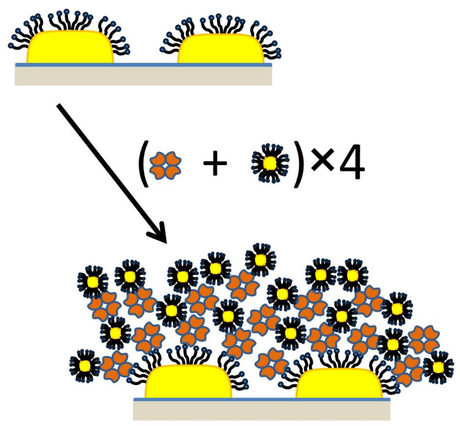
The response of different mannose-modified LSPR transducers to binding of Con A.

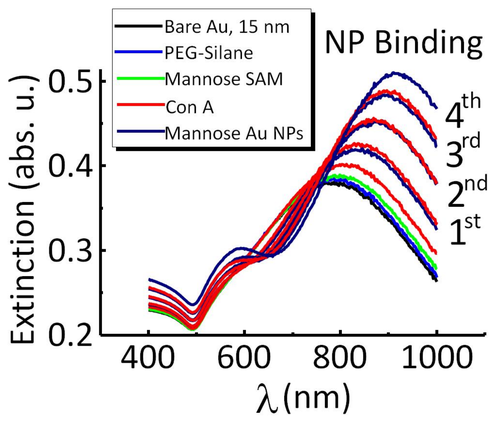
Flow-cell binding kinetics of Con A to carbohydrate-modified LSPR transducers

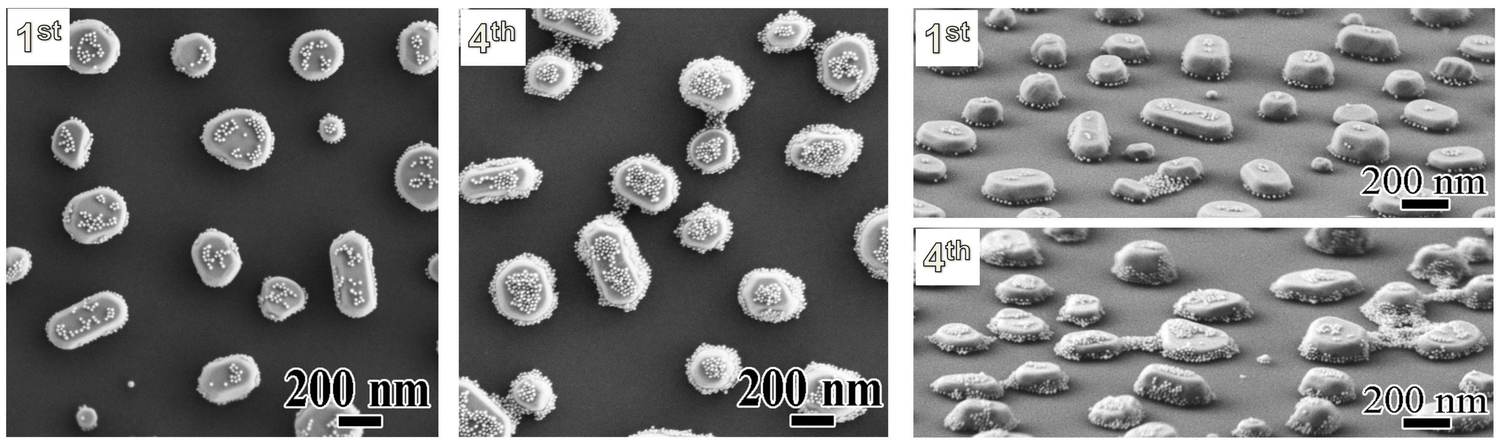


Left: Kinetics of Con A binding to carbohydrate-modified, 5 nm Au island transducers.
Center: Kinetics of Con A binding to mannose-coated transducers, at low protein concentrations.
Right: Fit of the kinetic data to a Langmuir isotherm.

Imaging and enhanced sensing of Con A on gold islands using mannose-functionalized Au NPs







Schematic illustration, LSPR spectra and HRSEM images (plan view, left; projection view, right) of NP-enhanced Con A recognition using a single and multiple binding of Au NPs coated with Mannose-PEG-thiol on 15 nm Au island transducers. [Con A] = 1 μM. The active form of Con A is a tetramer with 4 mannose binding sites.

Conclusions

Use of Au island films and synthetically-modified carbohydrates enables the development of LSPR tranducers for specific recognition and HRSEM imaging of protein-carbohydrate interactions. Improved sensing and imaging is achieved using carbohydrate-modified Au NPs. Smaller islands show better response, while larger islands provide superior imaging as well as separation between the plasmon bands of the islands and NPs.