LSPR TRANSDUCERS FOR SENSING AND IMAGING OF PROTEIN-CARBOHYDRATE INTERACTIONS

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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

Mannose-functionalized gold NPs

Citrine-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 LSRR 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 LSRR transducers

Flow-cell kinetics of Con A to carbohydrate-modified LSRR transducers

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

Flow-cell kinetics of Con A binding to carbohydrate-modified, 5 nm Au island transducers.


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

Schematic illustration, LSRR 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 LSRR transducers 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.