Specific Detection of Molecules with Nano-SPR

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The dynamics in living organisms is governed by a complex network of interacting macromolecules. For example, in a process like cell division a dozen of proteins interact in a subtle and interconnected way of subprocesses to finally define a division place or to generate the constriction force in the cell wall. To fully understand, model, and potentially influence such a process, it is important to quantify binding affinities between all possible partners, preferentially without introducing fluorescent labels. However, most of the label-free techniques used to study binding affinities require the analysis of one pair of binding partners at a time, making the quantification of a complex interaction network a laborious and slow effort.

We have tackled this problem in a novel way by employing individual gold nanorods as sensing elements. Each gold nanorod responds to binding events near its surface by a shift in the plasmon resonance wavelength. The nanorods are connected to proteins via specific tags, making it simple to generate a library of nanoparticles. Particles from this library are deposited on a common substrate for simultaneous quantification of the interaction of proteins with a common target molecule. We demonstrate the power of this easily upscalable approach by determining the binding affinities of three essential cell division proteins to the target FtsZ, a protein involved in constriction of the cell envelope during prokaryotic cell division.

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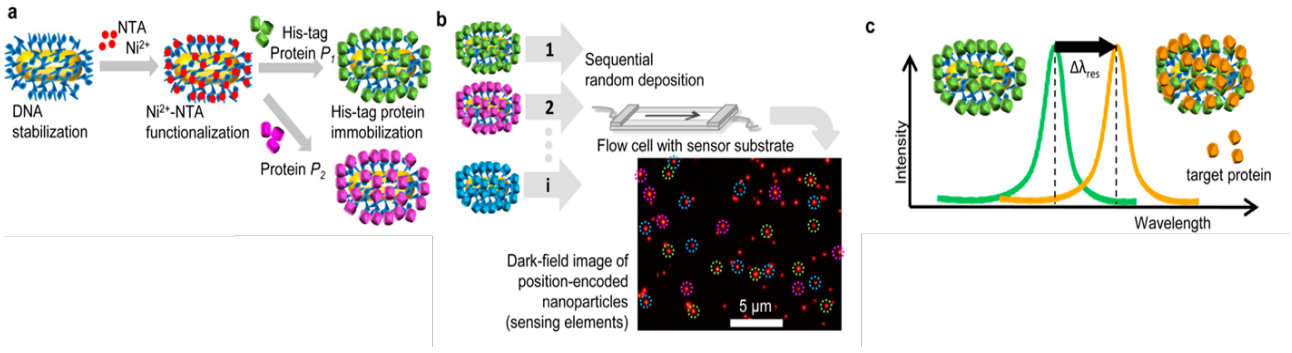

Fig. 1: *Principle of NanoSPR: particle functionalization, sensor fabrication, and detection principle.* ***(a)*** *Scheme of the two-step functionalization strategy used to immobilize a protein Pi on gold nanoparticles.* ***(b)*** *Consecutive deposition of particles 1...i while recording their positions after each deposition step creates a position encoded sensor (inset). The inset shows a dark-field image of the resulting randomly deposited gold nanorods. Each nanorod serves as a sensing element for a specific protein–target interaction.* ***(c)*** *The binding of target proteins T injected into the flow cell to nanoparticles covered by proteins Pi produces a shift* $\Delta\lambda$*res in the plasmon resonance [1].*

[1] R. Ahijado-Guzmán et al., Nano Letters, 14 (2009), 5528-5532