# Nanotechnology Approaches for Enhancing the Sensitivity and Throughput of Biosensors

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Nanotechnology is an emerging new discipline that has brought new exciting possibilities in life sciences. Its first applications are in the area of biosensing where miniaturization is expected to bring direct benefits by improving the throughput of sensors. In addition, some of the new physical nanoscale phenomena could be utilized to develop more sensitive sensing techniques with the hope to reach the ultimate, single molecule sensitivity. This talk will outline how nanotechnology might fulfil its promises by giving selected recent examples for enhancing sensitivity and throughput of biosensors:

1. Special optical properties of gold nanoparticles can be used to design biosensors based on the localized surface plasmon resonance phenomena. Adsorption events on single particles can be monitored where the shape and size of the particles determine the sensitivity.[1] The optical coupling between closely placed particles is even more interesting for biosensing because of the field enhancement that takes place between neighbouring particles. Although even single molecule sensitivity can be achieved using this concept there is still a lack of understanding about how to optimize the coupling effect.[2,3] Nevertheless applications e.g. for visualization of strain have already been demonstrated.[4]
2. The electrical conductivity of gold nanoparticles provides another possibility for applications. The plasmonic properties can be combined with electrochemistry or nanowire-based sensing, giving useful additional information about interfacial ion effects such as the Stern-layer formation.[5]
3. Membrane proteins are fragile and difficult to handle, but also highly important drug targets. The combination of microfabrication, polyelectrolyte multilayers, and self-assembly enabled the realization of ion-channel containing biomembranes over nanopores that are stable for weeks opening the possibility for high-throughput ion-channel screening.[6]
4. One of the most successful and widespread high-throughput protein analysis tools is microarray technology. The arrays are traditionally made by spotting process. We present a robust and simple method as alternative via slicing hydrogel networks that contain the sample of interest.[7,8]

Overall, this presentation will illustrate the diverse application possibilities offered by nanotechnology highlighting the importance of combining top-down and bottom-up approaches.

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[1] Shape Dependent Sensitivity of Single Plasmonic Nanoparticles for Biosensing; T. Sannomiya, et al; Journal of Biomedical Optics, in press.
[2] In situ sensing of single binding events by localized surface plasmon resonance; T. Sannomiya, et al. Nanoletters, 8(10): 3450-3455, 2008.
[3] Biosensing by Densely Packed and Optically Coupled Plasmonic Particle Arrays; T. Sannomiya, et al. Small, 5(16): 1889-1896, 2009.
[4] Strain mapping with optically coupled plasmonic particles embedded in a flexible substrate; T. Sannomiya, et al. Optics Letters, 34(13): 2009-2011, 2009.
[5] Electrochemistry on a Localized Surface Plasmon Resonance Sensor; T. Sannomiya, et al., Langmuir, 2009, in press.
[6] A gigaseal obtained with a self-assembled long-lifetime lipid bilayer on a single polyelectrolyte multilayer-filled nanopore; K. Sugihara, et al.; ACS Nano, 2010, in press.
[7] Multilayers of Hydrogels Loaded with Microparticles: A Fast and Simple Approach for Microarray Manufacturing
M. Bally, et al.; Lab Chip 10, 372-378, 2010.
[8] Microarrays Made Easy: Biofunctionalized Hydrogel Channels for Rapid Protein Microarray Production; V. de Lange, et al., ACS Applied Materials & Interfaces, Submitted 2010.