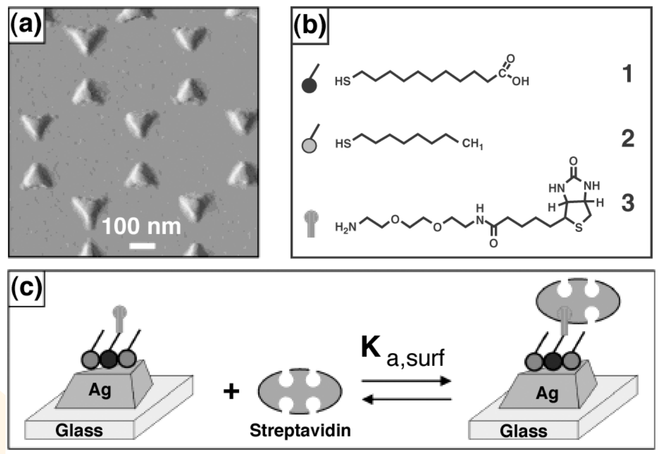
Triangular silver nanoparticles as affinity sensors

In the search for more and better ways to detect molecules in chemical and biologic sensors, the focus is shifting from surface plasmon resonance (SPR) on surfaces to SPR on noble metal nanoparticles. Richard Van Duyne and Amanda Haes at Northwestern University demonstrate that triangular silver nanoparticles can serve as sensitive, selective affinity biosensors.

Nanoparticles of noble metals exhibit a unique localized SPR effect, similar to conventional SPR, that allows detection of molecules attached to the surface. Small changes in the refractive index near the noble metal surface translate into changes in the extinction wavelength—the wavelength at which the particle no longer absorbs photons—which makes the nanoparticles very sensitive to attached molecules.

Triangular silver nanoparticles are especially responsive to the local dielectric environment. In the presence of alkanethiol absorbates, a red-shift wavelength change of 3 nm has been reported for these particles; this change was caused by only 60,000 alkanethiol molecules per nanoparticle.

The researchers conducted detailed studies of these nanoparticles using the well-studied biotin–streptavidin system.



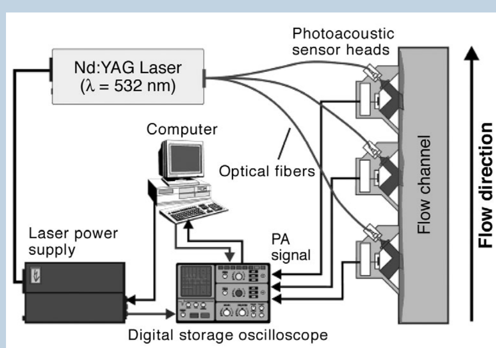
(a) An atomic force microscopy image of triangular silver nanoparticles and schematics of (b) the surface chemistry of the nanobiosensors and (c) streptavidin binding to a biotinylated nanobiosensor.

The wavelength shift method provided a limit of detection in the low-picomolar to high-femtomolar region. The response was amplified by using biotinylated gold colloids. (*J. Am. Chem. Soc.* **2002,** *124,* 10,596–10,604)

The sounds of biofilms

They grow on your teeth and inside water pipes and are even used to treat wastewater, yet biofilms—aggregates of microorganisms that live at aqueous interfaces—are not easy to study. For one thing, these ubiquitous films are 85–95% water by wet weight. Reinhard Niessner and his colleagues at the Technical University of Munich and the Institute of Water Quality Control and Waste Management (both in Germany) demonstrate that by using photoacoustic spectroscopy (PAS), they can for the first time monitor depth-resolved changes in a biofilm.

To test their approach, the researchers constructed a flow chamber with three photoacoustic sensor heads along a 260-mm channel and a controlled flow of water and nutrients. To enhance cell adhesion, the prisms on the sensor heads were coated with an aminoalkylsilane. Depth resolution of the sensors was ~10 µm.



Three heads are better than one. Photoacoustic sensor system with a flow channel for monitoring biofilms.

The thickness of a biofilm determined by PAS agreed well with the value found by confocal laser scanning microscopy. Moreover, the PAS signals for films grown on the sensor heads for 24 h differed very little when repeated under identical conditions.

Using the PAS data for monitoring, the researchers found that the flow rate affected film growth on the sensors and that significant detachment of the biofilm occurred at a pH >11. The introduction of iron oxide particles caused more complex behavior, with the film absorbing particles and eventually sloughing off flocs from the biofilm base. (*Environ. Sci. Technol.* **2002,** *36,* 4135–4141)