Optical detection of proteins using gold nanoparticles

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In this study we describe the development of a detection system for the sensitive and fast analysis of proteins. The immunological method uses gold nanoparticles to detect proteins at the nanogram level, as is required for clinical diagnosis.

Gold nanoparticles are characterised by their intensive light absorption which is caused by excitation of collective oscillations of valence band electrons, the so called plasmon resonance. The plasmon resonance wavelength is, amongst others, a function of the direct particle environment so that changes therein can be monitored spectroscopically.

Subject of this work is the surface modification, functionalization and bioconjugation of this kind of nanoparticles with a diameter in the range 20-60 nm. First we used as a test system, the protein ovalbumin and a specific antibody.

Bioconjugates of the gold nanoparticles and antibodies are produced in solution and characterised. The formation of antigen-gold nanoparticle conjugates is detected by an increase in hydrodynamic diameter as determined by dynamic light scattering (DLS). An analysis time of 10 minutes is sufficient to detect the immune complex formation. This is accompanied by a change in the absorption properties of the nanoparticles. Using UV/Vis spectroscopy this can be monitored and it is possible to quantify the shift of the plasmon resonance wavelength. The system is sensitive in the concentration range 0.06-0.25µg/ml. When the size dependence of this diameter increase is analysed, the larger particles result in a higher relative change as compared to the small (20 nm) particles.

The test system is then adopted to the detection of alpha-fetoprotein. This protein is a relevant tumor marker. Sensitivity can be provided here in the relevant concentration range of 0.15-0.5µg/ml.

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