1-P und 2-P-excited SERS for biodiagnostic sensing

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As demonstrated by a number of works in the recent past, the tailoring of the plasmonic and surface properties of metal nanostructures for the construction of efficient substrates is the key to a successful application of surface-enhanced Raman scattering (SERS), in particular in biodiagnostic applications. Nanoparticles and nanoaggregates from gold and silver have proven as versatile SERS-active structures for many analytical purposes. Here we will show results obtained in the process of construction of optical probes and sensors for bioanalytical applications. We aim at constructing such probes in a way that permits efficient delivery and functionalization with target sequences in addition to optimum SERS enhancement. For the characterization of the properties of the nanoparticles and their aggregates, direct (electron microscopy) and indirect methods (UV/Vis absorption, dynamic light scattering, DLS, and small angle x-ray scattering, SAXS) have been used.

The delivery of nanoparticulate SERS substrates has to be adapted to the morphology and ultrastructure of a biological sample. Here, we will also report on in situ generation of gold and silver nanostructures directly in situ, prior to the Raman experiment. Several aspects, such as the accessibility of "hidden" substructures, as well as the change in spectroscopic perspective due to the extreme localization of the SERS signals were observed when we generated nanoparticles in situ in complex biomatrices such as pollen outer layers [1]. Different Raman processes were shown to be useful for obtaining the vibrational information [2, 3]. The application of one- and two-photon-excitation with sensors applied to eukaryotic cells will be demonstrated. Utilization of two-photon excited (=hyper) Raman scattering is only possible due to the SERS process. Due to different selection rules it enables the observation of spectral features that cannot be found in 1-P Raman spectra, such as IR-active or silent modes.

References:

[1] V. Joseph, F. Schulte, U. Panne, and J. Kneipp, *submitted*.
[2] J. Kneipp, H. Kneipp, K. Kneipp, *Proc. Natl. Acad. Sci. USA* 103, 117149-17153 (2006).