Microstructured optical fiber for pathogen detection via localized surface plasmon resonance sensing and surface enhanced Raman spectroscopy

Barbara Seise[1], Andrea Csaki[1], Anka Schwuchow[1], Wolfgang Fritzsche[1], Karina Weber[1, 2], Dana Cialla[1, 2], Juergen Popp[1, 2]

[1]Institute of Photonic Technology, Albert-Einstein-Straße 9, 07745 Jena, Germany
[2]Institute of Physical Chemistry and Abbe Center of Photonics, Friedrich Schiller University Jena, Helmholtzweg 4, 07743 Jena, Germany

Metal nanoparticles are available with optical properties in the ultraviolet to near infrared range induced by their different shapes, sizes and materials. The potential of those plasmonic nanoparticles lies in the wide range of possible applications. As an example the spectral position of the localized surface plasmon resonance (LSPR) strongly depends on the change of the refractive index in close vicinity to a metallic surface. Thus, LSPR sensing is very sensitive and allows the detection of biomolecular interaction.[1]
Furthermore, the strong field enhancement on the nanoparticle surface due to the resonant excitation of surface plasmon polaritons is used for the effective amplification of the Raman signals. The so-called surface enhanced Raman spectroscopy (SERS) combines the molecular fingerprint specificity of the Raman effect with potential single molecule sensitivity. Therefore, SERS is an attractive tool in bioanalytics.[2]

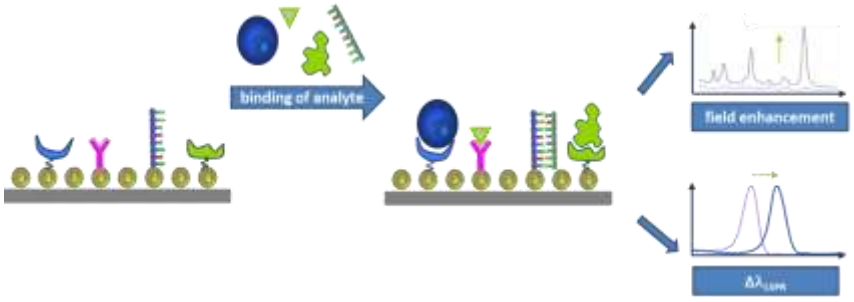

Figure 1: Nanoparticles with recognition element serve as LSPR and SERS sensor respectively. Binding of analyte to recognition elements attracts attention to spectral shift and field enhancement respectively.

Within this contribution, a suspended core fiber (SCF) with three holes containing metal nanoparticles as plasmonic structures on the internal capillary wall is presented as innovative optical device allowing both LSPR and SERS readout. Implementation of self-assembling monolayer (SAM) techniques enables plasmonic structures with an even distribution of metal nanoparticles. These microstructured optical fibers can be used as sensors for DNA sensing (Figure 1). [3]

[1] A. Csáki et al., in: P. E. Chow (Ed.): "Gold Nanoparticles: Properties, Characterization and Fabrication", p 245-261, Nova Sci. Pub., 2010.
[2] K. Hering et al., *Ana. Bioana. Chem.*, 390, 1, 113-124 (2008).
[3] A. Csaki et al., *Small*, 6, 2584–2589 (2010).

Acknowledgements:
Funding for research project “Multishell tuning of plasmonic core-shell nanoparticles” (DFG Fr1348/12-1) and “Preparation of incorporated plasmonic layers in MOFs” (IPHT) is gratefully acknowledged. We thank Franka Jahn for the SEM images.