Tip-enhanced Raman spectroscopy (TERS) – applications in the life sciences

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In the recent years optical techniques that reveal lateral resolution well beyond the diffraction limit became more and more accessible. Especially useful has been the combination of near-field optics and Fluorescence spectroscopy. Here even single molecule detection is feasible and already utilized in biomedical applications. Since Raman spectroscopy is a comparable insensitive spectroscopic technique progress here was much slower. However, the distinct signal enhancing properties of surface enhanced Raman scattering (SERS) allowed unique combination of Raman spectroscopy and near-field optical techniques. Utilizing only field enhancing sites at scanning probe tips that are smaller than the diffraction limit results in a field enhancement at the tip as well (tip enhanced Raman scattering TERS) and allows lateral resolution down to 20 nm. Theoretical models predict even considerably smaller values.

While a major challenge is the optimization of the probes with respect to high enhancement factors our goal is the application of this method to problems in life science.

Surface enhanced Raman spectra of nucleobases molecules have been obtained and can be used as a spectroscopic database. We are working in parallel on TERS of the deoxynucleotides of nano crystals of DNA monomers and on the combination with topographical analyses from atomic force microscopy (AFM) of DNA immobilised on solid surfaces. These experiments are used for TERS studies of single molecule RNA and first results on the direct probing of a single RNA strand using TERS will be demonstrated.

Another subject is the study of cell membranes or cell walls in-vivo by TERS. TERS spectra will be shown and implications of the measurements with respect to lateral resolution will be discussed.

References

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