

TIP ENHANCED RAMAN SPECTROSCOPY FOR BIOANALYTICAL STUDIES WITH MOLECULAR RESOLUTION

Dana Cialla¹, Tanja Deckert-Gaudig², Volker Deckert^{1,2,3}, Jürgen Popp^{1,3}

¹ Institute of Physical Chemistry, Friedrich-Schiller-University Jena, Helmholtzweg 4, 07743 Jena, Germany

² Institute for Analytical Sciences (ISAS), Bunsen-Kirchhoff-Straße 11, 44139 Dortmund, Germany

³ Institute of Photonic Technology (IPHT), Albert-Einstein-Straße 9, 07745 Jena, Germany

E-mail: Jürgen.Popp@ipht-jena.de

For a lot of analytical and bioanalytical devices Raman spectroscopy plays an important role, since molecular fingerprint information can be derived. However, the Raman effect is a very weak one why surface enhanced Raman spectroscopy (SERS) is very often applied to enhance the weak Raman signals. SERS is based on a Raman signal enhancement by several orders of magnitude due to an interaction of the analyte molecules with a nanostructured metallic surface. In order to also obtain a high spatial resolution in the nanometer range, the SERS technique can be combined with atomic force microscopy (AFM) or scanning tunneling microscopy (STM). This combinatorial approach is called tip enhanced Raman spectroscopy (TERS) and has been recently applied to study different kinds of analytes. Various TERS studies deal with the investigation of carbon-based clusters like e.g. carbon nanotubes and bucky balls (C₆₀) or with organic dyes and DNA components like DNA bases. [1] The work presented within this contribution reports about TERS spectroscopic investigations of complex biological objects like bacteria and viruses.

By placing a silver-coated AFM tip directly on the surface of a bacterial cell, TERS spectra with a high signal-to-noise ratio are detected with dominant contributions of molecules of the outer cell wall, like proteins, carbohydrates or lipids. However, over time the TERS fingerprint information changes in band position and band intensity due to fluctuations of cell components on the outer cell wall. Hence, cell dynamics can be investigated without any labelling of molecules since every chemical group has a characteristic spectroscopic fingerprint. [2]

Furthermore we succeeded in recording TERS spectra of a single tobacco mosaic virus particle with a high grade of reproducibility. These results show the great potential of the TERS technique for single virus detection. [3]

References:

[1] E. Bailo and V. Deckert, 'Tip-enhanced Raman scattering', *Chem. Soc. Rev.*, **37**, 921-930 (2008).

[2] U. Neugebauer, P. Rösch, M. Schmitt, J. Popp, C. Julien, A. Rasmussen, C. Budich and V. Deckert, 'On the Way to Nanometer-Sized Information of the Bacterial Surface by Tip-Enhanced Raman Spectroscopy', *ChemPhysChem*, **7**, 1428-1430 (2006).

[3] D. Cialla, T. Deckert-Gaudig, C. Budich, M. Laue, R. Möller, D. Naumann, V. Deckert and J. Popp, 'Raman to the limit: tip-enhanced Raman spectroscopic investigations of a single tobacco mosaic virus', *J. Raman Spectrosc.*, published online.