Application of plasmonic nanostructures in food analysis

A. Radu,[a,b] M. Jahn, [a,b] K. Weber,[a,b] D. Cialla-May,[a,b] J. Popp[a,b]

[a] *Friedrich Schiller University Jena, Institute of Physical Chemistry and Abbe Center of Photonics, Helmholtzweg 4, 07745 Jena, Germany*
[b] *Leibniz-Institute of Photonic Technology Jena, Albert-Einstein-Str. 9, 07745 Jena, Germany.*

A proper uptake of vitamins is vital for the well-functioning of the organism and general health. Vitamin A deficiency, in particular, leads to night blindness, skin lesions, loss of appetite, epithelial keratinization and susceptibility to infections. [1,2] It is, accordingly, important to ensure one follows a dietary regime that provides the essential amount of vitamin A. However, in doing so, information about food composition and quality are required.
Within this contribution, the spectroscopic characterization and detection of vitamin A (retinol) and its precursor, pro-vitamin A (β-carotene) employing surface enhanced Raman spectroscopy (SERS) as analytical tool is introduced. Due to the interaction of molecules with a nanostructured metallic surface, the Raman scattering is enhanced by several orders of magnitude. As a result, the SERS technique allows the detection, analysis and quantification of target analytes by providing molecular specificity, high sensitivity and fast detection times. For the fabrication of SERS-active metallic nanostructures, bottom-up and top-down techniques are available. [3]
As an example, we will present the preparation of an easy, cost and time effective SERS substrate, based on high density digital versatile discs, supporting localized as well as propagating surface plasmon polaritons modes. To gain most efficient from the signal enhancement due to the propagating mode, SERS spectra are recorded as function of the angle of incident. By doing so, the optimized measuring conditions are found to be between 4 and 6 degrees. Following the characterization of the as-prepared substrates, their application in the detection of food related analytes such as retinol and β-carotene was investigated.

ACKNOWLEDGMENT

Funding of research projects “QuantiSERS” and “Jenaer Biochip Initiative 2.0” within the framework “InnoProfile Transfer – Unternehmen Region“ the Federal Ministry of Education and Research, Germany (BMBF) is gratefully acknowledged.
Yerzhan Ye. Ussembayev, Technical University of Delft, Kavli Institute of Nanoscience, Bionanoscience, Lorentzweg 1, 2628 CJ, Delft, the Netherlands and Stephanie Hoeppener, Jena Center for Soft Matter, Philosophenweg 7, 07743 Jena, Germany and Friedrich Schiller University Jena, Institute of Organic and Macromolecular Chemistry, Humboldtstr. 10, 07743 Jena, Germany is gratefully acknowledged.

[1] J. Płonka et al., Food Analytical Methods 5 (2012) 1167-1176.
[2] R. Ronald et al.,Vitamin Analysis for the Health and Food Sciences, CRC Press 1998.
[3] D. Cialla et al., Analytical and bioanalytical chemistry 403 (2012) 27-54.