Magnetic beads for SERS based sequence specific DNA detection

Susanne Pahlow[1], Karina Weber[1] and Jürgen Popp[1,2]

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

Magnetic beads are a versatile tool for many bioanalytical purposes including isolation and purification of nucleic acids [1], proteins [2] and cells [3]. Beyond that, they can be further employed for medical applications like magnetic resonance imaging (MRI) [4], magnetic hyperthermia [5] and targeted drug delivery [6]. The high popularity of magnetic beads especially in bioassays is based on their unique properties. Their superparamagnetic core on the one hand allows facile separation from the sample, on the other hand the magnetic beads can be resuspended easily, since they are only magnetic in presence of an external magnetic field. Furthermore they provide numerous possibilities for surface modification with functional groups.
We combined magnetic beads and SERS (Surface Enhanced Raman Spectroscopy) for sequence specific DNA detection [7]. The combination of SERS and magnetic beads has certain advantages over other methods for sequence specific DNA detection. For example, real time PCR (Polymerase Chain Reaction) has only limited multiplexing possibilities. SERS detection avoids these problems and offers high sensitivity and an excellent potential for multiplexing since each molecule has a specific fingerprint region and the bandwidth of vibrational modes is small. For our assay we modified magnetic beads with single stranded DNA by using different immobilization strategies. Two covalent immobilization methods and one approach using streptavidin-biotin interaction were utilized in order to bind capture DNA to the surface of the magnetic beads. Subsequently hybridization with a complementary fluorescence dye labelled target strand was performed. For the detection of the oligonucleotides fluorescence spectroscopy as well as SERS can be employed. Fluorescence based detection is more suitable for detecting a single DNA sequence and if quantification of the target DNA is desired. SERS based detection is capable of parallel detection of several DNA sequences. We choose PCR products amplified from DNA of epizootic pathogens to prove that our assay makes a very promising technique for multiplex detection of DNA.

References

[1] K. Obata, H. Tajima, M. Yohda, T. Matsunaga, *Pharmacogenomics* 3, 697-708 (2002).
[2] M. Franzreb, M. Siemann-Herzberg, T.J. Hobley, O.R.T. Thomas, *Appl. Microbiol. Biotechnol.* 70, 505-516 (2006).
[3] I. Safarik, M. Safarikova, *J. Chromatogr. B* 722, 33-53 (1999).
[4] M.V. Yezhelyev, X. Gao, Y. Xing, A. Al-Hajj, S. Nie, R.M. O'Regan, *Lancet Oncol*. 7, 657-667 (2006).
[5] A.K. Gupta, M. Gupta, *Biomaterials* 26, 3995-4021 (2005).
[6] K.J. Widder, A.E. Senyei, D.G. Scarpelli, *Proc. Soc. Exp. Biol. Med.* 58, 141-146 (1978).
[7] K.K. Strelau, A. Brinker, Ch. Schnee, K. Weber, R. Möller, J. Popp, *J. Raman Spectrosc.* 42, 243-250 (2011).

Acknowledgement
Funding of the research project 'FastDiagnosis' from the Federal Ministery of Education and Research, Germany (BMBF) is gratefully acknowledged.