Single cell identification based on vibrational spectroscopy

U. Neugebauer[1], J. H. Clement[2], T. Bocklitz[3], C. Krafft[1], J. Popp[1,3]

1. Institute of Photonic Technology, Albert-Einstein-Str. 9, D-07745 Jena, Germany
2. Department of Internal Medicine II, Friedrich-Schiller-University Jena, Erlanger Allee 101, D-07740 Jena, Germany
3. Institute of Physical Chemistry, Friedrich-Schiller-University Jena, Helmholtzweg 4, D-07743 Jena, Germany

Current medical diagnosis could profit significantly from fast, highly sensitive and quantitative cell identification from easily accessible bodily fluids. One example are circulating tumour cells in peripheral blood of cancer patients [1]. These cells are extremely rare and therefore difficult to detect. However, a reliable, fast and easy identification could help in early state cancer diagnosis as well as monitoring the success of cancer treatment [2]. The goal of the research initiative “Jena Cell Identification Group” (JenZIG) is to establish new methods for single cell analysis and sorting. In this contribution we present the vibrational spectroscopic characterization (IR and Raman) of different cells that can be found in peripheral blood such as leukocytes, lymphoblast and tumour cells.

Leukocytes were isolated from blood from healthy donors. Breast carcinoma derived tumour cells (MCF-7, BT-474) and lymphoblasts (OCI) were prepared from cell cultures. Raman images were collected from dried cells on calciumfluoride slides using 785 nm laser excitation. FTIR images were collected from the same cells using a 64×64 FPA detector and single IR spectra were recorded with a MCT detector. Unsupervised statistical methods (principal component analysis) are used to visualize spectral differences and cluster formation according to the cell type. With the help of supervised statistical methods (linear discriminant analysis and support vector machines) a classification model with high accuracy rates for the differentiation of the cells is built. The model was successfully applied to identify single cells from an independent mixture of cells based on their vibrational spectra. The correctness of the assignment was confirmed by fluorescence staining of the cells after the measurement.

Acknowledgements: Financial support of the European Union via the Europäischer Fonds für Regionale Entwicklung (EFRE) and the "Thüringer Kultusministerium (TKM)" (Project: B714-07037) is highly acknowledged.

References:

[1] J. H. Clement, M. Schwalbe, N. Buske, K. Wagner, M. Schnabelrauch, P. Görnert, K. O. Kliche, K. Pachmann, W. Weitschies, K. Höffken, *J Cancer Res Clin Oncol* 132, 287-292 (2006).

[2] S. Nagrath, L. V. Sequist, S. Maheswaran, D. W. Bell, D. Irimia, L. Ulkus, M. R. Smith, E. L. Kwak, S. Digumarthy, A. Muzikansky, P. Ryan, U. J. Balis, R. G. Tompkins, D. A. Haber, M. Toner, *Nature* 405, 1235-1239 (2007).