# *FTIR Spectroscopy in Recognition of Lifestyle Diseases: Studies on Blood Plasma of Animal Models*

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This research is directed onto the recognition of endothelial dysfunction associated with several lifestyle diseases by the collection of FTIR spectra of blood plasma. The dysfunction of endothelial cells that are lining the vascular walls is associated with platelet activation, pro-inflammatory and pro-thrombotic mechanisms, which are expected to affect the concentration and structure of major biocomponents of plasma. Here, we focus on several animal models representing systemic and pulmonary hypertension, diabetes, atherosclerosis, breast cancer and its metastasis to lungs, which are strongly conjugated with an improper function of the endothelium. We investigate acute states of the disorders, the progression of the diseases as well as an effect of treatment to assess to what extent infrared spectroscopy is sensitive to such events. This contribution shall highlight primarily differences between chosen disorders, which can potentially provide an insight into spectral diagnosis and mechanism specific for a given disease. In addition, we will discuss a proof of principle study on applied 0.5 µL drops of blood, to discriminate samples obtained from the dataset, including data analysis techniques to enable this. We will describe our approach to diagnose civilization diseases based on the blood plasma *via* FTIR imaging spectroscopy in combination with advanced multivariate statistics for the selective identification of each disorder [1-3]. The plasma deposits samples were analyzed with an Agilent FTIR spectrometer equipped with a 128x128 FPA detector and then with the support of PCA and LDA methods. PCA analysis clearly differentiated the advanced state of the diseases with variance of ca. 15-60 % for the entire spectral region exhibiting IR bands. Interestingly, the major discriminators found in PC loadings plots suggested that both type of hypertension are mainly characterized by changes in the secondary structure of proteins and the content of free amino acids whereas diabetes and atherosclerosis showed an increase of absorbances in the regions of bands attributed to lipids and fatty acids. In turn, plasma of cancer metastasis exhibited spectral features associated with a higher level of phospholipids and phosphorylated proteins. Interestingly, all disorders studied here showed a higher level of tyrosine-rich proteins and RNA than the corresponding controls. These studies show the powerful capability of FTIR spectroscopy for the discrimination of several diseases and their progression.

## References

[1] E. Staniszewska-Slezak, A. Fedorowicz, K. Kramkowski, A. Leszczynska, S. Chlopicki, M. Baranska, K. Malek, *Analyst* 140, 2273-2279 (2015).
[2] E. Staniszewska-Slezak, A. Rygula, K. Malek, M. Baranska, *Analyst* 140, 2412-2421 (2015).
[3] E. Staniszewska, A.K. Bartosz, K. Malek, M. Baranska, *Biomedical Spectroscopy and Imaging*, IOS Press, 2, 317-330 (2013).

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