(Nano)softsensor arrays for bioanalysis

The output of an individual sensor/receptor consists of potentiometric/voltammetric/optical signal measured in response to a chemical stimulus. Therefore, usually one feature per sensor is monitored at a time (1D signal), for the correlation between the analyte concentration and the sensor response. The obtained calibration curve serves as a model for the studied sensor/receptor – analyte interaction and is a basis for the analyte determination.

However, the rational design of receptors is impractical for not fully characterized analytes (e.g. many large biomolecules), and in opposite cases, in which a highly specific receptor can be designed, the synthetic work required can be a vary laborious task. Moreover, analyzing complex mixtures of analytes using a lock-and-key approach requires both the design and synthesis of many receptors for each component in the mixture, which complicates this work even more.

For these reasons, novel approach to sensing that also mimics biology is differential sensing. Mammalian olfaction and gustation employ cross-reactive receptors that interact differentially with odorants and tastants. Instead of identifying an odorant or tastant molecule by its strong affinity for one particular receptor, recognition is achieved by the composite response of the array of cross-selective receptors in the nose or on the tongue. The result is a characteristic pattern – fingerprint, which can be perceived by brain and stored in an organism's memory.

Arrays of cross-sensitive receptors allow to provide characteristic fingerprint for investigated samples exactly in the same manner. But in this case, instead of 1D signal, multidimensional data are obtained. The information hidden in such fingerprint is not accessible straightforward (via standard calibration) – it must be deconvoluted by numerical processing.

The aim of the project is the development and performance characterization of (nano)softsensor arrays for bioanalytical applications. As receptors two kinds of nanomaterials are planned to be applied and compared for arrays fabrications: quantum dots and chemosensitive nanospheres/micelles. Changes in their optical properties during their contact with chosen bioanalytes will form characteristic fingerprints of investigated samples, that will be numerically processed for identification, recognition, classification and/or quantification of various analytes having similar structure: amino acids, oligopeptides, neurotransmitters, hormones, nucleosides, metabolites, etc. During the tests, both absorbance (absorption spectra) and fluorescence (2D fluorescence maps) properties of the studied nanomaterials will be considered.

This solution phase-based softsensing methodology has a great potential as rapid, universal, simple to fabricate assays that could find application in medical diagnostics, system biology, proteomic and metabolomic research – in all these areas, where various structurally similar compounds must be identified and/or quantified. Moreover, the proposed methodology is fully compatible with high-throughput analysis offered by microplate readers, which are now used in biochemical laboratories as standard equipment.

The presented proposition is of very high scientific novelty – according to our best knowledge both nanomicelles based-sensor array for differential sensing, nor quantum dots fingerprinting with the use of 2D fluorescence spectroscopy, has not been presented before.