The benefits of photoacoustic methods applied to membrane transport studies

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The presentation focuses on the Gdansk's group recent advancements in the field of membrane transport studies as needed for transdermal delivery systems, greatly fueled by unique type of noninvasive photoacoustics-based measurements performed. In general, the photoacoustics modalities are based upon the detection of acoustic response of a sample following the absorption of modulated energy flux. A unique feature of the methods is related to a correspondence between the adjustable incident light modulation frequency *f*, and the sample depth contributing to the photoacoustic response. As such, the measurements can be performed in two configurations, i.e. for constant *f* and variable incident light wavelength λ (spectroscopy mode), and for variable *f* and constant λ (depth-profiling mode). The latter one offers the acquisition of the pigment concentration distribution within a system under study, or the evolutions of the concentration profiles if the measurements are performed in a cyclic manner. In the case considered here, the transdermal delivery-mimicking system consisted of a cellulose membrane in a one-side contact with a model drug. A broad photoacoustic characterization of the system, involving spectroscopy-based stationary measurements and sorption/desorption experiments, along with the time-resolved spectroscopy and depth-profiling for the dynamic system (a direct observation of the membrane transport process) allowed for the development and validation of a novel mathematical approaches to the membrane transport processes quantification, and highlighted the impact of the interfacial mass transfers on the overall membrane sorption kinetics. This, in fact, puts into question one of the longstanding paradigms of the passive membrane transport, i.e. the diffusion-controlled character of the membrane sorption processes [1,2].

[1] Rochowski P., Niedziałkowski P. and Pogorzelski S. (2020) IJP, 580, 119233.
[2] Rochowski P. (2023) IJP, 580, 123452.

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