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Nanoplasmonic sensing as a novel tool for unraveling interactions between ionic liquids and phospholipid vesicles

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PURPOSE OF THE ABSTRACT

Microsystems and miniaturized instrumental techniques, enabling dynamic and real-time monitoring of biological processes, are key technologies for future progress in biochemistry, biotechnology, and medicine. Nanoplasmonic sensing (NPS) is a novel, highly surface-sensitive indirect sensing method based on the optical phenomenon of localized surface plasmon resonance of metallic nanostructures. In principle, each plasmonic particle acts as a nanosized optical sensor with a characteristic maximum-extinction wavelength that depends on nanoparticle properties including size, shape, interspacing, and local dielectric environment. Changes in the factors cause a shift in the maximum extinction wavelength, which can be monitored and recorded in real-time.

The use of ionic liquids (IL) in industrial processes is greatly enhanced leading to the development of advanced and novel industrial applications. Due to the possible health aspects related to their direct interaction with biomembranes, there is a strong interest in developing biosensing methods to evaluate the toxicological effect of ILs on synthetic biomimetic systems. This project explores the NPS methodology for studying interactions between phospholipid vesicles, acting as excellent artificial models for biomembranes, and industrially relevant ILs.

Our results showed that depending on the IL, in situ real-time lipid removal or binding processes occur. [DBNH][OAc] (1,5-diazabicyclo(4.3.0)non-5-enium acetate) did not have any significant effect on the phospholipid vesicles, while the strongest and the most significant effect was observed with [P14444][OAc] (tributyl(tetradecyl)phosphonium acetate), which caused profound changes in the phospholipid-layer architecture leading to vesicle rearrangement and consequent phospholipid removal. Interestingly, when phospholipid vesicles were exposed to [P4441][OAc] (tributylmethylphosphonium acetate) at a very high concentration, only a mild effect was observed. The effect of ILs on phospholipid vesicles is dependent on the alkyl chain length, resulting in a deeper permeation of ILs with a longer alkyl chain into the phospholipid membranes. Taken together, the findings in this work suggest that the NPS-based methodology provides an excellent and powerful tool for the elucidation of the nuanced changes in the interactions between ILs and biomembranes, shedding new light on membrane binding, permeation, and IL-induced phospholipid removal, which is of great importance for the overall understanding of the harmfulness of ILs.

FIGURES

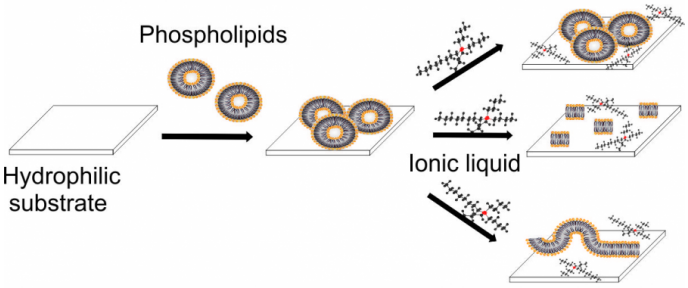

FIGURE 1

Figure 1.

Schematic presentation of the study.

FIGURE 2

KEYWORDS

nanoplasmonic sensing | localized surface plasmon resonance | ionic liquid | liposome

BIBLIOGRAPHY

[1] J. Witos, G. Russo, S.-K. Ruokonen, S. K. Wiedmer, Langmuir 2017, 33, 1066-1076.

[2] J. A. Jackman, B. Spackova, E. Linardy, M. C. Kim, B. K. Yoon, J. Homola, N.-J. Cho, Chem. Commun. 2016, 52, 76-79.

[3] M. Dacic, J. A. Jackman, S. Yorulmaz, V. P. Zhdanov, B. Kasemo, N.-J. Cho, Langmuir 2016, 32, 6486-6495.