Study of the Adsorption and Binding Dynamics of Phospholipids on Graphene Platforms using the Quartz Crystal Microbalance Technique

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Understanding how graphene interacts with lipid membranes is of the utmost importance since such interfaces have latent biotechnological applications. Mimicking the structure of cell membranes on supporting substrates is an area that has attracted the attention of biologists and biomedical researchers. The interaction between zwitterionic lipid vesicles and graphene derivatives, such as graphene oxide (GO) and thermally reduced graphene oxide (rGO), was investigated using the Quartz Crystal Microbalance with Dissipation Monitoring (QCM-D). Lipid monolayers (Fig. 1) were obtained on rGO-coated QCM sensors while small unilamellar vesicles (SUVs) stayed unruptured jointly with bicelle-like structures to form a mixed membrane on GO-coated sensors [1]. These results are in agreement with our previous report on MD simulations of graphene-supported phospholipid biomimetic membranes [2]. Additionally, we have demonstrated that phospholipids exhibit higher mobility on graphene compared to the traditional SiO_2 substrate [3]. The effectiveness of the obtained supported lipid membranes was demonstrated through the assay of a binding event of high specificity, as that of the Biotin-Avidin complex. The presented results demonstrate the applicability of graphene derivatives as supporting layers for lipid membranes to form different structures. Our methodology can be extended to studies of higher complexity such as high-affinity biomolecular detection, immunoassays or peripheral protein insertion into lipid membranes.

References

[1] Melendrez, D., Jowitt, T., et al. *Nanoscale* 10.5 (2018): 2555-2567.
[2] Willems, Nathalie, et al. *ACS nano* 11.2 (2017): 1613-1625.
[3] Hirtz, Michael, et al. *Nature communications* 4 (2013): 2591.

Figures

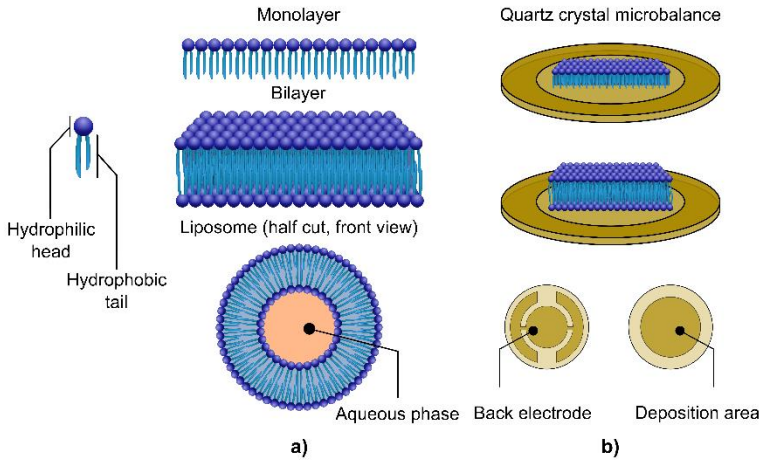

Figure 1: Representation of lipid structures from the basic lipid unit. a) Studied lipid structures, b) Lipid membranes on QCM surfaces