Asymmetric Model Membranes: Studying Lipid Distribution in TiO_2-Supported Lipid Bilayers

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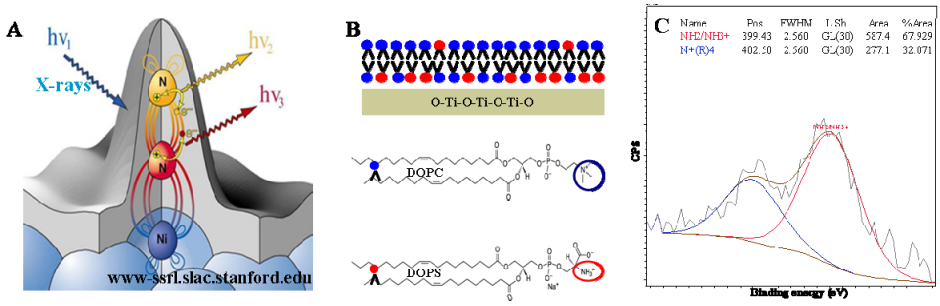

Figure1: A) Principle of X-Ray photoelectron spectroscopy (XPS), based on photoelectric effect; electrons are excited with X-rays, photoelectrons are emitted from the sample and observed at specific kinetic energy characteristic of a particular element. B) Upper: the diagram of asymmetrically distributed PC and PS lipids on TiO_2 surface; middle and bottom: structures of PC and PS lipids. C) Detailed XPS spectra of the nitrogen region of PC and PS lipid mixture on titania. The two peaks correspond to the two different nitrogens on PC (blue) and PS (red), respectively.

Development of biocompatible materials for implant, biosensor, and environmental applications requires understanding of the intricate interactions that occur at the bio/non-bio interfaces. As an example of such an interface, we have been focusing our attention on a biophysical model system consisting of phosphatidyl serine (PS)-containing liposomes and TiO_2. Titanium is used in numerous medical applications, in part due to the biocompatibility of its oxide, TiO_2.[1] Despite the wide-spread application, its interactions with biological systems remain poorly understood. Liposome behavior on TiO_2 is governed by TiO_2-PS-Ca interactions.[2, 3] This behavior parallels that of PS-containing liposome fusion in solution, driven by PS-Ca-PS complex formation.[4] However, there is until now no direct evidence of a PC-Ca-TiO_2 complex formation. Furthermore, bilayers that result from the rupture of PS-containing liposomes on TiO_2 are asymmetric,[5] mimicking membranes of cells in terms of lipid distribution.[6] Quantifying the composition and the distribution of lipids in solid-supported lipid bilayers is a challenging task however. In the present study we show a simple in-house method based on X-ray photoelectron spectroscopy (XPS) for investigating the inner leaflet composition of solid-supported lipid bilayers. This allows us both to study lipid distribution and to access information about lipid-surface interactions. The principle of the method is summarized in Figure 1.

[1] B. Kasemo, J. Prosthet. Dent. 49, 832 (1983).
[2] S. Camarero et al., Manuscript in preparation (2011).
[3] F. F. Rossetti et al., Langmuir 21, 6443 (2005).
[4] H. L. Casal et al., Biochemistry 26, 7395 (1987).
[5] F. F. Rossetti, M. Textor, and I. Reviakine, Langmuir 22, 3467 (2006).
[6] A. J. Verkleij et al., Biochimica Et Biophysica Acta 323, 178 (1973).