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Structural and topographical characteristics of carbon nanotubes-lipid monolayer and its application in biomembrane model

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Abstract – Biomembrane model systems have been studied to investigate the action of carbon nanotubes in synthetic membrane at the molecular level. The penetration of CNT at 2 mg/ml concentration into dipalmitoylphosphatidylcholine (DPPC) monolayers was studied with Brewster angle microscopy (BAM) by recording BAM images simultaneously with kinetics absorption and surface pressure increase (Fig1). The BAM images give complementary informations corroborating with π-A isotherm. The result suggests that CNTs were able to interact even at high surface pressure values (Fig2) indicate that the presence of the CNT affects the packing of the membrane, which may be indicative of nanotoxicity.

The expansions in the fields of nanotechnologies and the great promise for industrial and biomedical nanoparticle applications have made the assessment of health risks. Toxicological studies suggest that carbon nanotube and other nanoparticles may cause adverse health effects, but the fundamental cause effect relationships are ill defined. Carbon nanotubes (CNTs) are considered one of the most promising nanomaterials with a variety of applications, consequently, the professional and public exposure to the nanomaterial is supposed to increase dramatically in the coming years [1]. Furthermore, few toxicological studies of CNTs have been reported. Thus, systemic toxicological including biomembrane model systems have become one of the most urgent areas of collaborative research in material science and biology.

In this sense, this study involves the interaction between carbon nanotubes with biomembrane model systems, aiming to investigate the action of this nanomaterial in cell membranes at the molecular level. In addition, the penetration of CNT at 2 mg/ml concentration into dipalmitoylphosphatidylcholine (DPPC) monolayers was studied at the microscopic level with Brewster angle microscopy (BAM) by recording BAM images simultaneously with kinetics absorption and surface pressure increase.

The obtained results indicated that the nanomaterial was inserted into the monolayer, since the molecular area values shifted to higher values, compared with obtained for pure DPPC. The BAM images and the evolution with the surface pressure of the reflectivity of BAM images give complementary information on the interaction and structural characteristics of DPPC monolayer with CNT, which corroborate the conclusions derived from the π-A isotherm. This finding suggests that CNTs were able to interact even at high surface pressure values, 30 mN/m, under controlled ionic strength, pH and temperature. Therefore the results confirm the interaction between CNTs and cell membrane models, and indicate that the presence of the nanomaterial affects the packing of the synthetic membranes, which may be indicative of nanotoxicity.

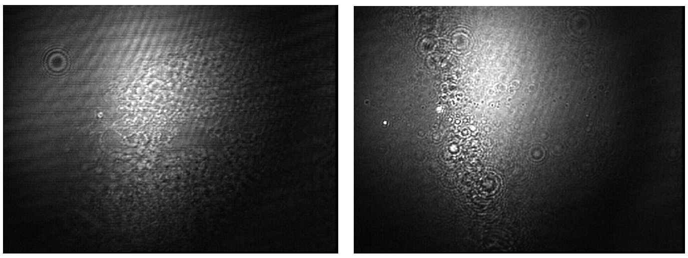

Figure 1: BAM image for DPPC on a buffer (phosphate buffer, pH 7.4) with CNT-PAMAM G2 complex ($2 mgml^{-1}$) in the subfase. A) Kinetics absorption image 40 min before compression and B) surface pressure-area image for the same system (π=48 mN/m).

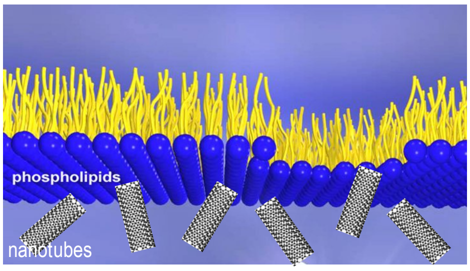

Figure 2: Biomembrane model for carbon nanotube and phospholipid interaction.

[1] M. Soloviev, J Nanobiotechnology, 5:11 (2007) 1-3.