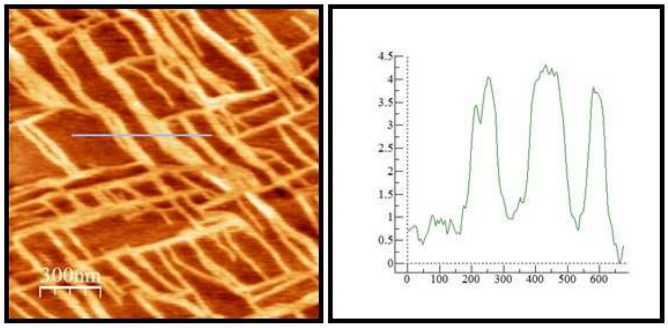
Acoustic manipulation of self assembling proteins on lipid surfaces

Álvaro Alonso

Laboratorio de Biofuncionalización de Superficies (Biofunctional Surfaces)
Instituto de Catálisis y Petroleoquímica CSIC, Madrid



The FtsZ with the thiol group attached to supported bilayers on mica containing lipids modified with a maleimide group. Addition of GTP induced polymerization and the formation of highly ordered structures (Figure 1).

The aim of this project is to explore the use of surface acoustic waves to guide the self assembling of bacterial cytoskeletal protein FtsZ on lipid surfaces (ref. 1). The long term objective is to develop the potential of this self-assembling protein as biological scaffolds for nanostructuring.

In bacteria, FtsZ accumulates on the inner side of the cytoplasmic membrane during cell division to form a dynamic ring structure that contributes to exert force to divide the cell (ref. 2). In vitro, FtsZ self assembles on surfaces forming micrometer sized dynamic structures of various shapes in the presence of the phophorilated nucleotide GTP. Modified proteins containing a thiol group can convalently attach to supported lipid bilayers forming two dimensional patterns that can be observed with the atomic force microscope.

The first part of the work was directed to modify the protein chemically to introduce a thiol group through the Traut's reagent (2-iminothiolane) that reacts with the protein primary amines. Mass spectrometry was used to identify the modified aminoacids.

The second part of the work involved growing the lipid-protein structures on the appropiate substrate. The use of acoustic waves requires depositing the bilayers on a piezoelectric material, lithium niobate (LiNbO3) in this case. Since bilayers do not fuse properly on this substrate, it has to be covered by a thin layer of silicon dioxide. We have used plasma-enhanced chemical vapor deposition (PECVD) to deposit a thin silicon dioxide layer with a roughness ranging from to 2 to 4 nm, valid for the correct fusion of the liposomes and the formation of a lipid bilayer.

We will present the results on the preparation and characterizarion of the lipid-protein complexes on LiNbO3 not subject to acoustic excitation. We will also present the characterization of the surfaces exposed to surface acoustic waves, analyzed by AFM after fixation of the proteins.

1) J. Neumann, M. Hennig, A. Wixforth, S. Manus, J.O. Raidler, M.F. Schneider. Transport, Separation, and Accumulation of Proteins on Supported Lipid Bilayers. Nano Lett, 10 (2010) 2903-2908.

2) Jesús Mingorance, Germán Rivas, Marisela Vélez, Paulino Gómez-Puertas and Miguel Vicente. Strong FtsZ is with the force: mechanisms to constrict bacteria. Trends in Microbiology, 18 (2010) 348-356