ENZYME-ASSISTED ATTACHMENT OF GOLD NANOPARTICLES ONTO PATTERNED ORGANIC SURFACES

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The current fascination with nanoscale materials and surface patterns is due to the novel physico-chemical properties that these can exhibit. Integrating nanoscale features into organic and hybrid organic/inorganic thin films are vital for applications in the areas of nano-microelectronics, optoelectronics, nano-microfluidics, biosensing and biomaterials. Conventional serial approaches in nanofabrication include electron-beam lithography and scanning probe lithography, which are both very expensive and tedious. Hence, novel parallel methods that are compatible with organic materials must be developed.

In this poster, the spatially-directed attachment of gold nanoparticles (NPs) by an enzyme will be demonstrated. Phospholipase D (PLD) is part of the phospholipase enzyme family which is specific to phospholipids. PLD is capable of a transphosphatidylation reaction in which the phosphatidyl moiety of a phospholipid is transferred to a primary alcohol, releasing the choline group of the phospholipid. We are using the PLD transphosphorylation reaction to attach alcohol-functionalized gold NPs to laterally structured phospholipid monolayers.

First, the preparation of the phospholipid substrate will be presented. The phospholipid used is an analogue of DPPC with a methyl-disulfide functionality at the end of one of the alkyl chain (Figure 1).

This disulfide functionality allows us to form a self-assembled monolayer of phospholipid with a thiol-gold bond between the alkyl chains and a gold substrate. In this conformation, the surface exposed phospholipid head is accessible to the enzyme for biochemical processing. This monolayer was characterized by ellipsometry (thickness of 3 nm) and by polarization modulation infrared reflection absorption spectroscopy (PM-IRRAS) which indicated the presence of ordered alkyl chains. Tof-SIMS also confirms the presence of an exposed phosphate head at the gold surface. The creation of a mixed surface pattern was achieved by microcontact printing. The pattern consists of 10 μm circular dots of inert tetradecanethiol monolayer in a matrix of phospholipids. This pattern will serve as a template to spatially direct the selective attachment of gold NPs.

The synthesis of water-soluble hydroxy-capped gold nanoparticles (NPs) will also be presented. Up to date, very few hydroxy-terminated water-soluble gold NPs have been reported. A short ethylene glycol ligand, $OH(CH_2CH_2O)_3CH_2CH_2SH$, was prepared and used to form monolayer-protected gold NPs that are soluble in aqueous solution. The synthesis of the gold NPs was performed using the Brust and Schiffrin method with the addition of dioctylamine [1] . The particles were characterized by TEM and measured 2 nm in diameter. These were small enough to be characterized by ^{1}H and ^{13}C NMR.

Finally, preliminary results obtained for the PLD catalyzed attachment of the gold NPs to the phospholipid monolayer will be presented (Figure 2).

In this work, the combination of biology and surface chemistry is being exploited to functionalize the surface with gold NPs. This enzymatic modification of solid-supported biomimetic monolayers will allow us to establish the true scope and utility of enzymes as nanostructuring tools.

References:

[1] P. Scrimin *et al. Langmuir*, 24 (**2008**) 120.

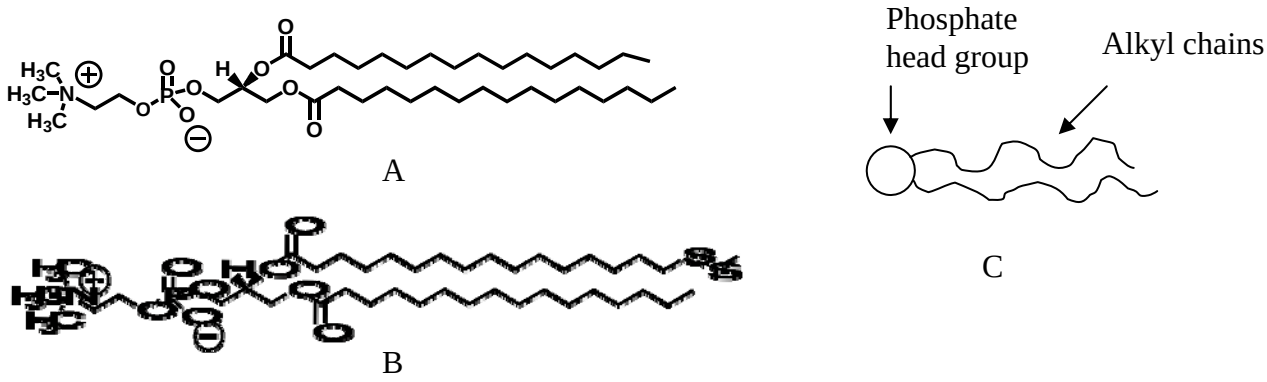

Figure 1. Structure of phospholipids A) 1,2-dipalmitoyl-sn-glycero-3-phosphocholine, DPPC B) 1-Palmitoyl-2-(16-(S-methyldithio)hexadecanoyl)-sn-glycero-3-phosphocholine DS-DPPC C) cartoon of a phospholipid.

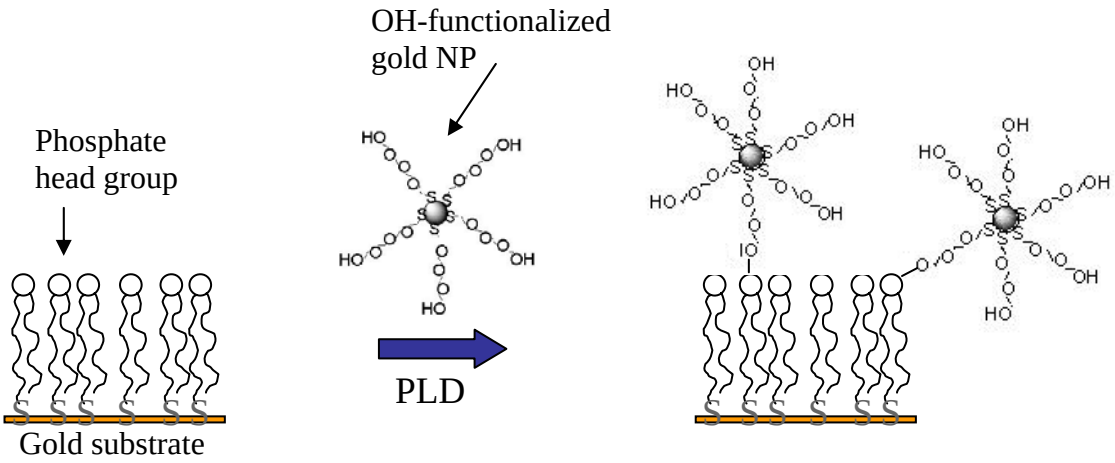

Figure 2: PLD catalyzed attachment of gold NPs onto a phospholipid monolayer.