Interaction of biofunctionalized gold nanoparticles with model lipid membranes

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Introduction

The study of the interaction of different molecules or nanoparticles with the cell membrane is a key factor when developing new biocompatible systems for diagnostic or therapeutic applications. The aim of our work was to syntheize and functionalize gold nanoparticles and study the interaction with a model phospholipid membrane. Langmuir monolayers at the air/water interface were prepared as model membranes. These floating monolayers are simple and practical models for biological membranes since many parameters can be tuned easily (composition, density of molecules in the membrane, composition of the subphase, etc.).

Gold nanoparticles

Gold nanoparticles were prepared by the widely used Turkevich method [1,2].

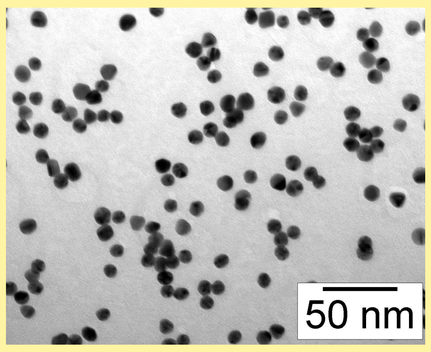


Fig. 1. TEM image of Au NPs

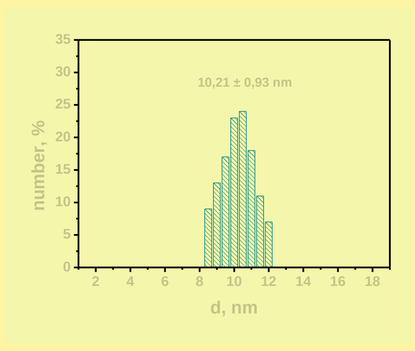


Fig. 2. Size distribution histogram of Au NPs

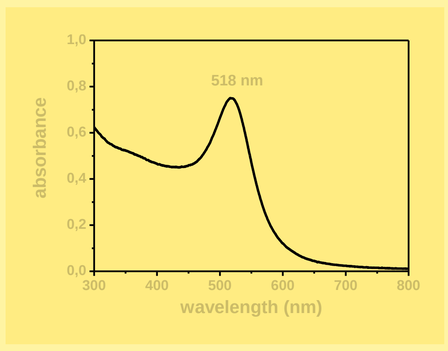


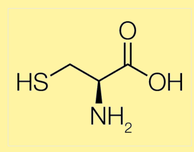
Fig. 3. UV-Vis absorbance spectra of Au NPs aqueous sol

Biofunctionalisation of Au NPs was realized with cysteine (cys) and gluthatione (gsh) around pH 7.4, which is characteristic for biological systems. Aggregation of the Au NPs can be avioded at this pH.

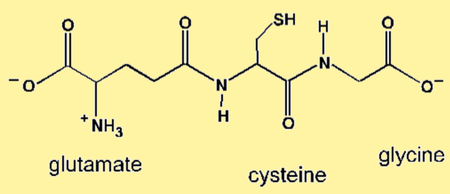
Table 1. Characteristics of functionalized Au NPs

	Au	Au-cys	Au-gsh
DLS (nm)	11	12	12
ζ potential (mV)	-52	-61	-65

cysteine (cys)



gluthatione (gsh)



Model membrane systems

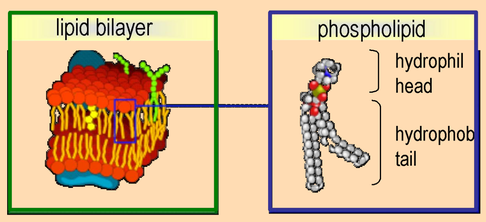
Model membrane materials:

- **DPPC (dipalmytoil-phosphatidilcoline)**
- **Asolectin (mixture of phospholipids and fatty acids)**

Subphases:

- **ultrapure water**
- **Au NPs sol (pH: 7.4)**

Au NPs sol



Membrane preparation:

Langmuir monolayer of the lipids was formed at the air/liquid interface.

Study of the interaction

The interaction between functionalized Au NPs and the Langmuir mnlayer membrane was followed by the change in the surface pressure of the floating film.

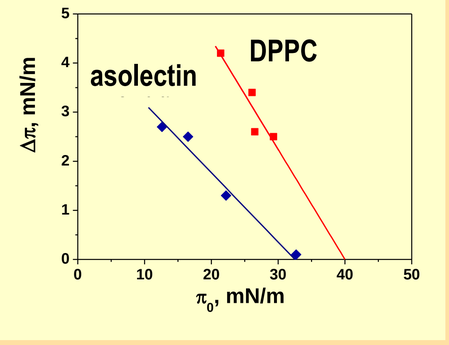
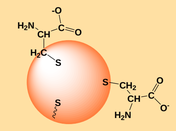


Fig. 4. Change in surface pressure due to interaction of Au-cys NPs with the monolayer membrane.



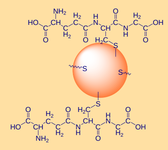
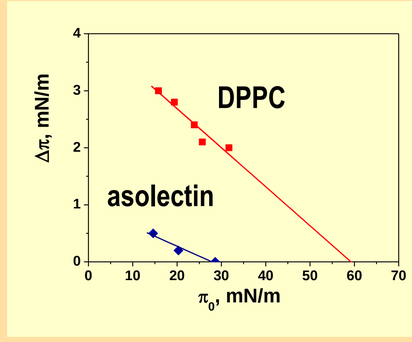
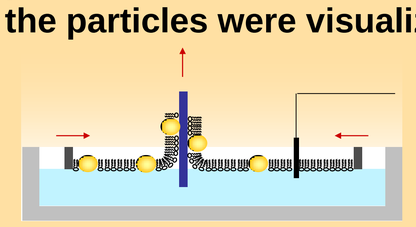


Fig. 5. Change in surface pressure due to interaction of Au-gsh NPs with the monolayer membrane.



The increase in the surface pressure reveals the incorporation of the functionalized nanoparticles in the membrane.

The floating monolayers with incorporated Au particles were transfered onto soild substrates and the particles were visualized by AFM images.



AFM image clearly shows the gold nanoparticles in the membrane.

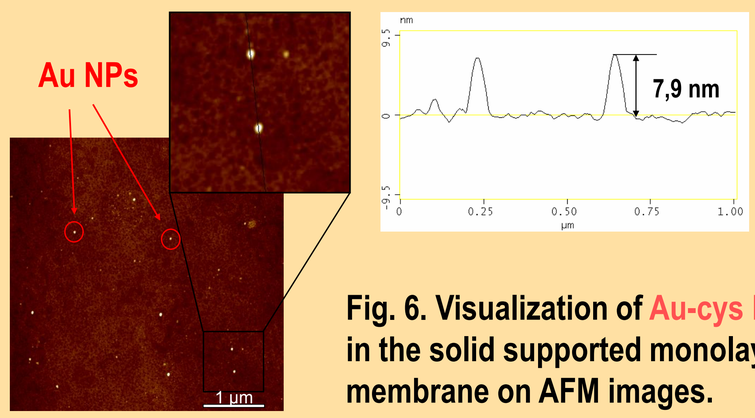


Fig. 6. Visualization of Au-cys NPs in the solid supported monolayer membrane on AFM images.

Conclusions

We have synthesized monodispersed, spherical gold nanoparticles which were biofunctionalized with cysteine and gluthatione. The interaction of the cysteine and gluthatione coated Au particles with lipid monolayers at the air/liquid interface as model membranes was studied. Surface pressure measurement results and AFM images reveal the successful penetration of metal nanoparticles into the model membrane.

References

[1] J. Turkevich, Gold Bull. 3 (1985) 18.

[2] A. Majzik, Colloids Surf B, 81 (2010) 235.

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