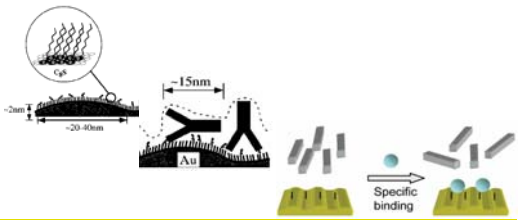
NANOSTRUCTURED LAYERS AS SUBSTRATES FOR LIQUID CRYSTAL LOCAL ORDERING

www.imt.ro/NANOPROSPECT

National Institute of Materials Physics
National Institute R&D Chemistry & Petrochemistry
Institute of Virology of the Romanian Academy

I. Zgura, T. Beica, S. Frunza, L. Frunza, P. Ganea, A. Nuta, A.-A. Sorescu, I. Bunea, C. N. Zaharia

It has been shown that self-assembled monolayers (SAMs) can be formed from alkanethiols on the surface of gold, either as single crystals or as thin films (e.g. [1,2]); these monolayers can further specifically bind proteins. If these bonds are formed in the presence of aligned liquid crystal (LC) molecules, the alignment is disturbed and thus reports the presence of the proteins.



After N.L. Abbott's group/Langmuir 2001, 17, 5595

We have established [3] the experimental conditions for the deposition of nanostructured gold layers on the surface of glass plates by vaporization at small incidence angle (large angle with the normal direction) leading to nanostructured columnar semi-transparent layers. Then the layers were characterized by complementary methods; additional support was given by observing the molecular alignment present in the liquid crystal cells obtained with these gold layers.
However, the nanostructured gold layers obtained directly onto the glass support have a rather short life especially when they work in watery solutions. Instead of improving the gold adherence by deposition of certain substrates, we have used polystyrene (PS) layers [4] containing benzene rings that might interact with gold atoms. A rather strong interaction of gold atoms with the substrate molecules was found indeed on the basis of the X-ray diffraction (XRD) and spectroellipsometry (SE) measurements. Moreover, we found that functionalization by self-assembling of hexadecanethiol [5] offers consistent alignment properties in a displaying cell with nematic liquid crystal.

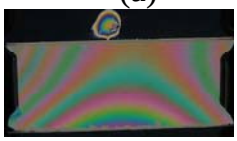
(a)

(b)

Conoscopic images of LC orientation in the cells with gold layer deposited at 80º without (a) and with SAM overlayer (b).

Nanostructured layers of SiOx-type were deposited onto glass plates under vacuum at 60º incidence angle [6]. The layers were further functionalized (with APES, DSS) to bind proteins (BSA, BSA-b). We found that the silicon monoxide amount is small and decrease more by a hydrophylization oxygen plasma treatment. Liquid crystal cells were then obtained to observe the molecular alignment imposed by such treated glass plates. The planar orientation of the liquid crystal molecules was observed in all the studied cases. A rather strong interaction of the organic layers with the substrate was then advanced leading to observed orientation.
It was experimentally found a factor which might quantify the interaction between the model proteins and the functionalized SiOx layer [7].

(a)



(b)

Optical images under crossed polarizers for cells having sample plates as follows: a) SiO60+P+APES +DSS+BSA; b) SiO60+P+ APES+DSS+BSA-b plate. The reference plate was unidirectionally rubbed SiO.

References
[1] R. G. Nuzzo, D. L. Allara, J. Amer. Chem. Soc., 105, 4481 (1983).
[2] V. K. Gupta, N. L. Abbott, Langmuir 12, 2587 (1996).
[3] T. Beica, S. Frunza, I. Zgura, et al., J. Optoelectron. Adv. Mater., 12, 347-353 (2010).
[4] I. Zgura, T. Beica, S. Frunza, et al., J. Optoelectron. Adv. Mater. 12, 354-359 (2010).
[5] I. Zgura, T. Beica, S. Frunza, et al., J. Optoelectron. Adv. Mater. 12, 1729-1738 (2010).
[6] I. Zgura, T. Beica, S. Frunza, et al., Optoelectron. Adv. Mat.–Rapid Comm. 5, 318 – 323 (2011)
[7] I. Zgura, T. Beica, S. Frunza, et al., Patent application 2010.

Acknowledgements
The authors thank the Romanian Ministry of Education and Research for financial support by the PNII Project VIRNANO/2007.