BACTERIAL PROTEIN CRYSTALS AS PURE BIOMIMETIC NANO-MOLECULES

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S-layers, one of the most common cell envelope components of prokaryotic organisms, represent the simplest biological membrane developed during evolution [1]. Once these glyco(proteins) are in solution they have the ability to self-assemble into 2-D crystalline structures at the air-water interface [2], on lipid films [3], on liposomes [4], and on solid supports [5]. These protein layer crystals, which have a relevant role protecting cells from external stimuli, are becoming of growing importance in nanotechnology due to the possibility of engineering functional bacterial fusion proteins [6-8], as well as of immobilizing nanoparticles [9] and *in situ* nucleation of ordered two-dimensional arrays of (cadmium sulphide) nanocrystals [10], in the pores of the 2-D protein crystal.

In this communication, we introduce three different aspects of the applications of the S-proteins in nanotechnology:

i) The functionalization of polyelectrolyte covered flat surfaces and hollow polyelectrolyte capsules with bacterial wild-type and fusion proteins [11]. We show that wild-type SbpA and the fusion protein SbpA-GFP recrystallized on cationic and anionic polyelectrolyte through a self-assembly process.

ii) The building of bacterial patterning with wild-type SbpA and two different bacterial fusion proteins (with GFP and streptavidine as functional biomolecules). We find that the proteins preserve their functionality [12].

iii) The manipulation of the protein-sample interaction by changing in a controlled manner the number of methylene units of the OH and CH_3 terminated branches of self-assembled monolayers (SAMs). We will show that difference in chain length leads to a phase transition from a protein bilayer to a protein monolayer, induces preferential side adsorption of a protein, and increases the crystal lattice parameters (a process that is not observed in bacteria) [13].

References:

[1] U. B. Sleytr, M. Sara, D. Pum, and B. Schuster. *Progress in Surface Science*, 68 (2001) 231
[2] D. Pum and U. B. Sleytr, *Landesr Academic Press*, Austin, TX, (1996) 175
[3] B. Schuster and U. B. Sleytr. *Reviews in Molecular Biotechnology*, 74 (2000) 233
[4] S. Küpcü, M. Sara, and U. B. Sleytr. *Biochim. Biophys. Acta*, 1235 (1995) 263
[5] D. Pum and U. B. Sleytr. *Thin Solid Films*, 244 (1994) 882
[6] D. Moll, C. Huber, D. Pum, U. B. Sleytr, M. Sara. PNAS 99 (2002) 14646
[7] N. Ilk, S. Kueckue, G. Moncayo, S. Klimt, R. C. Ecker, R. Hofer-Warbinek, E. M. Egelseer, U. B. Sleytr and M. Sara. Biochem. J. 379 (2004) 441
[8] J. L. Toca-Herrera, S. Küpcü, V. Diederichs, G.moncayo, D. Pum, and U. B. Sleytr. *Biomacromolecules* 12 (2006) 3298
[9] E.S. Gyorvary, A. O'Riordan, A.J. Quinn, G. Redmon, D. Pum, and U. B. Sleytr. Nanoletters 3 (2003) 315
[10] W. Shenton, D. Pum, U. B. Sleytr and S. Mann. Nature 389 (1997) 585
[11] J. L. Toca-Herrera, R. Krastev, V. Bosio, S. Küpcü, D. Pum, A. Fery, M. Sara and U. B. Sleytr. *Small*, 1 (2005) 339
[12] V. Saravia, S. Küpcü, M. Nolte, C. Huber, D. Pum, A. Fery, U.B. Sleytr, and J. L. Toca-Herrera. *Journal of Biotechnology* in press
[13] S. Moreno-Flores, A. Kashry, Schmittel, D. Pum, H.-J. Butt, U. B. Sleytr and J. L. Toca-Herrera. Submitted to *Nature Nanotechnology*