Smart nanomaterials built up from functional organic molecules and photosynthetic microorganisms

Gianluca M. Farinola

Dipartimento di Chimica Università degli Studi di Bari "Aldo Moro", Via Orabona 4, 70126 Bari, Italy
gianlucamaria.farinola@uniba

Abstract

Photosynthetic microorganisms represent a plentiful source of functional micro/nano structures optimized by billions of years of evolution. Combining such specialized structures with tailored molecules paves the way for intriguing new materials for photonics, electronics and biomedicine. The lecture will present smart nanohybrid materials obtained by chemical modification of silica microstructures from diatoms algae.

Diatoms are single-cell photosynthetic algae characterized by beautiful nanopatterned microscopic silica shells (frustules) with hierarchically-porous 3D morphology and intriguing mechanical and photonic properties. The possibility to manage these biosilica structures as multifunctional scaffolds by chemical modifications opens up the way to biotechnologically-produced nanomaterials with applications including bio-medicine, photonics, filtration, sensing and catalysis[1].

We use two approaches for the functionalization of diatoms biosilica with tailored organic molecules. The first is based on covalent attachment of the molecules on the silica shells, after removal of the organic cellular matrix. The second approach is based on *in vivo* incorporation of the molecules into the biosilica during the cells' growth.

The lecture will discuss examples of the two approaches. In the first case, *in vivo* incorporation of several classes of light emitting molecules (fluorescent conjugated compounds or phosphorescent organometallic complexes) in living diatoms results in nanostructured light emitting materials. For the second approach, the lecture will present covalent functionalization of biosilica with 2,2,6,6-tetramethylpiperidine-N-oxyl (TEMPO) (figure), an efficient scavenger of reactive oxygen species (ROS) in biological systems. Drug delivery properties of the TEMPO-biosilica for Ciprofloxacin, an antimicrobial against orthopedic implant related infections, will be discussed. The TEMPO-biosilica, combining Ciprofloxacin drug delivery with anti-oxidant properties, is demonstrated to be a suitable material for bone cells growth[2].

Our study points out at the combination of biotechnological production and chemical modification as a convenient approach to the synthesis of functional nanostructured materials.

References

[1] W. Yang, P. J. Lopez, G. Rosengarten *Analyst*,**136** (2011) 42

[2] S. R. Cicco, D. Vona, E. De Giglio, S. Cometa, M. Mattioli Belmonte, F. Palumbo, R. Ragni, G. M. Farinola *ChemPlusChem*, **80** (2015) 1063

Figure