

“Integrative Materials Chemistry : from Nanostructures to Hierarchical structures”

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Hybrid phases can be used to nanostructure or texture new inorganic nanomaterials (porous or non porous). The versatile synthetic conditions provided by bottom up strategies such as reactive molecular precursors or clusters, tunable processing temperatures and solvents and the adjustable rheology of the colloidal state allow for the mixing of the organic and inorganic components at the nanometer scale in virtually any ratio. These features, and the advancement of organometallic chemistry and polymer and sol-gel processing, make possible a high degree of control over both composition and structure (including nanostructure) of these materials, which present tunable structure-property relationships. This, in turn, makes it possible to tailor and fine-tune properties (mechanical, optical, electronic, thermal, chemical...) in very broad ranges, and to design specific systems for applications. Hybrid materials can be processed as gels, monoliths, thin films, fibers, particles or powders or can be intermediates to design materials having complex shapes or hierarchical structures. The seemingly unlimited variety, unique structure-property control, and the compositional and shaping flexibility give these materials a high potential in catalysis, biocatalysis, photocatalysis, etc.... This lecture will describe some recent advances on integrative chemistry that allows via a chemistry-process coupling to tailor made nanostructured and hierarchically structured functional inorganic and hybrid materials. Some of their properties will be discussed. For more information see few recent reviews :

0-The core contribution of transmission electron microscopy to functional nanomaterials engineering S. Carencu, S. Moldovan, L. Roiban, I. Florea, D. Portehault, K. Vallé, P. Belleville,^c C. Boissière, L. Rozes, N. Mézailles, M. Drillon, C. Sanchez, O. Ersen, *Nanoscale*, 2016, 8, 1260-1279.

1-**“Chimie douce”**: A land of opportunities for the designed construction of functional inorganic and hybrid organic-inorganic nanomaterials . C. Sanchez, L. Rozes, F. Ribot, C. Laberty-Robert, D. Grosso, C. Sassoie, C. Boissiere and L. Nicole, *Comptes Rendus Chimie*, 13, 3, (2010)

2-Hybrid materials science: a promised land for the integrative design of multifunctional materials

Lionel Nicole Christel Laberty-Robert, Laurence Rozes^a and Clément Sanchez, *Nanoscale*, 2014, 6, 6267-6292

3- Mesoscopically structured nanocrystalline metal oxide thin films, A. Carretero-Genevri; G. L. Drisko; D. Grosso; C. Boissiere; C. Sanchez, *Nanoscale*, 6, 14025, (2014)

4-Molecular Engineering of Functional Inorganic and Hybrid Materials

C. Sanchez, C. Boissiere, S. Cassaignon, C. Chaneac, O. Durupthy, M. Faustini, D. Grosso, C. Laberty-Robert, L. Nicole, D. Portehault, F. Ribot, L. Rozes, and C. Sassoie. *CHEM. MATER.* 2014 26 (1), 221-238

5-Nanoscaled Metal Borides and Phosphides: Recent Developments and Perspectives, Sophie Carencu, David Portehault, Cédric Boissière, Nicolas Mézailles, and Clément Sanchez. *CHEMICAL REVIEWS* 2013 113 (10), 7981-8065

6-Aerosol Route to Functional Nanostructured Inorganic and Hybrid Porous Materials, Boissiere, Cedric; Grosso, David; Chaumonnot, Alexandra; C. Sanchez. *ADVANCED MATERIALS* Volume: 23 Issue: 5 Pages: 599-623, 2011

7-Applications of advanced hybrid organic-inorganic nanomaterials: from laboratory to market Sanchez, Clement; Belleville, Philippe; Popall, Michael; et al. *CHEMICAL SOCIETY REVIEWS* Volume: 40 Issue: 2 Pages: 696-753, 2011

8- Molecular and supramolecular dynamics of hybrid organic-inorganic interfaces for the rational construction of advanced hybrid nanomaterials, Grosso, David; Ribot, Francois; Boissiere, Cedric; et al. *CHEMICAL SOCIETY REVIEWS* Volume: 40 Issue: 2 Pages: 829-848 2011

9- Design and properties of functional hybrid organic-inorganic membranes for fuel cells, Laberty-Robert, C.; Valle, K.; Pereira, F.; et al. *CHEMICAL SOCIETY REVIEWS* Volume: 40 Issue: 2 Pages: 961-1005 2011

10-Titanium oxo-clusters: precursors for a Lego-like construction of nanostructured hybrid materials, Rozes, Laurence; Sanchez, Clement, *CHEMICAL SOCIETY REVIEWS* Volume: 40 Issue: 2 Pages: 1006-1030 2011

11-Design, synthesis, and properties of inorganic and hybrid thin films having periodically organized nanoporosity, Sanchez, Clement; Boissiere, Cedric; Grosso, David; et al. *CHEMISTRY OF MATERIALS* Volume: 20 Issue: 3 Pages: 682-737 2008