

Mesoporous silica, periodic mesoporous organosilica, and mesoporous silicon nanoparticles for drug delivery and two-photon Photodynamic Therapy

Jean-Olivier Durand

Mesoporous silica nanoparticles (MSN) have attracted much attention the last decade for nanomedicine applications due to their biocompatibility, flexible functionalisation, tunable pore size and diameter. We describe here MSN engineered for two-photon triggered drug delivery or photodynamic therapy, in MCF-7 breast cancer cells. The two-photon triggered drug delivery system was based on a FRET mechanism from a two-photon dye in the walls of the MSN to an azobenzene moiety in the pores of the MSN (nanoimpellers). Concerning photodynamic therapy, a two-photon photosensitizer was encapsulated in the walls of the MSN. Two-photon photodynamic therapy was performed *in vitro* and *in vivo* on mice bearing colon xenografted tumors. We also studied the use of porous silicon nanoparticles (pSiNP) functionalized with both a photosensitizer and a targeting agent. Porous silicon is a biocompatible and biodegradable material which can generate $^1\text{O}_2$ when excited by visible light due to quantum-confinement effect. pSiNP had been shown to be degraded into non-toxic silicic acid byproducts *in vivo*. The multi-functionalized pSiNP studied here were able to target, image and kill cancer cells *in vitro* by photodynamic therapy mechanisms both with 1-photon and 2-photon excitation. Alternatively, the synthesis of disulfide-based biodegradable Periodic Mesoporous Organosilica Nanoparticles (nanoPMOs) was realized and the nanoparticles were efficient in delivering doxorubicin in cancer cells.

References

Mannose-6-Phosphate Receptor, A Target for Theranostics of Prostate Cancer,

Ophélie Vaillant, Khaled El Cheikh, David Warther, David Brevet, Marie Maynadier, Elise Bouffard, Frédéric Salgues, Audrey Jeanjean, Puche Pierre, Catherine Mazerolle, Philippe Maillard, Olivier Mongin, Mireille Blanchard-Desce, Laurence Raehm, Xavier Rébillard, Jean-Olivier Durand, Magali Gary-Bobo, Alain Morère and Marcel Garcia **Angewandte Chemie International Edition**, 2015, 54, 5952-5956.

Two-Photon Excitation of Porphyrin-Functionalized Porous Silicon Nanoparticles for Photodynamic Therapy

Emilie Secret, Marie Maynadier, Audrey Gallud, Arnaud Chaix, Elise Bouffard, Magali Gary-Bobo, Nathalie Marcotte, Olivier Mongin, Khaled El Cheikh, Vincent Hugues, Mélanie Auffan, Céline Frochot, Alain Morère, Philippe Maillard, Mireille Blanchard-Desce, Michael J. Sailor, Marcel Garcia, Jean-Olivier Durand, Frédérique Cunin **Advanced Materials**, 2014, 26, 7643–7648

Biodegradable Ethylene-Bis(Propyl) Disulfide-Based Periodic Mesoporous Organosilica Nanorods and Nanospheres for Efficient In-Vitro Drug Delivery

Croissant Jonas, Cattoen Xavier, Wong Chi Man Michel, Gallud Audrey, Raehm Laurence, Trens Philippe, Maynadier Marie, Durand Jean-Olivier. **Advanced Materials** 2014, 26, 6174-6180

Two-Photon-Triggered Drug Delivery in Cancer Cells Using Nanoimpellers

Croissant Jonas, Maynadier Marie, Gallud Audrey, Peindy N'Dongo Harmel, Nyalosaso Jeff L., Derrien Gaelle, Charnay Clarence, Durand Jean-Olivier, Raehm Laurence, Serein-Spirau Françoise, Cheminet Nathalie, Jarrosson Thibaut, Mongin Olivier, Blanchard-Desce Mireille, Gary-Bobo Magali, Garcia Marcel, Lu Jie, Tamanoi Fuyuhiko, Tarn Derrick, Guardado-Alvarez Tania, M., Zink Jeffrey I. **Angew. Chem. Int. Ed.**, 2013, 52, 13813-13817