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Biomedical applications of magnetically controlled magnetoplasmonic nanodomes

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The improvement of nanotherapies efficacy and the minimization of their side effects require the development of new methods to locally control the therapeutic action. This involves the active guidance of the nanotherapeutic agents to the site of action, and the controlled generation of the therapeutic effect. Here we present a novel nanostructure for the development of magnetically controlled and amplified photo-therapies: magnetoplasmonic nanodomes. The nanodomes are composed of a combined, magnetic and plasmonic, hemispherical shell deposited onto 100 nm diameter polymer beads. The variation of the materials and their thicknesses in the shell enables tuning both the optical and magnetic properties of the nanostructures. The very high plasmonic absorption of the nanodomes in the near-infrared is used for very efficient local optical heating to develop localized cancer photo-hyperthermia treatments. The strong ferromagnetism of the nanodomes keeping high colloidal stability allows the efficient remote manipulation with magnetic fields to easily regulate the level of photo-hyperthermia and locally amplify the photo-thermal effects. Moreover, given their asymmetric shape the nanodomes exhibit strong optic and magnetic anisotropies. Thus, the rotation of the nanodomes using alternating magnetic fields can be easily tracked optically using their different absorption depending on the orientation. Since the rotation of the nanoparticles depends strongly on the viscosity of the medium, which in turn depends on the temperature, the optical tracking of the rotation can be used to accurately determine the local temperature around the nanodomes, i.e., nanothermometry. The combination of the nanodomes efficient photo-hyperthermia with their nanothermometry capabilities, enables in-situ and real-time control of the efficiency of photo-hyperthermia treatments.

Recent Publications

1. Li Z et al. (2018) Simultaneous local heating/thermometry based on plasmonic magnetochromic nanoheaters. Small 14:1800868.
2. Zhang K et al. (2017) Photochemically activated motors: from electrokinetic to diffusion motion control. App. Mat. Interf. 9:44948–44953.
3. Fantechi E et al. (2017) Seeded growth synthesis of Au–Fe3O4 heterostructured nanocrystals: rational design and mechanistic insights. Chem. Mat. 29:4022–4035.
4. Otte MA et al. (2017) Metamirrors based on silicon nanowires with height gradients. Adv. Opt. Mater 5:1600933.
5. Serrà A (2017) Magnetically-actuated mesoporous nanowires for enhanced heterogeneous catalysis. Appl. Catal. B

Biography

B Sepulveda received his PhD degree in Physics from the Complutense University of Madrid in 2005. His post-graduate research was carried out at the Microelectronics Institute of Madrid (CSIC). In 2006 he started a two years Postoctoral stay at the Bionanophotonics group in Chalmers University (Sweden). In 2008 he joined the Catalan Institute of Nanoscience and Nanotechnology (ICN2) of Barcelona as Research Fellow, where he got a Ramon y Cajal grant in 2009. From 2012, he holds a permanent research position at the ICN2. During his scientific career, Dr Sepúlveda has acquired a highly multidisciplinary experience, focused on the development of photonic and magnetic nanostructures for biomedical and environmental control applications. In particular, he has acquired experience in very diverse fields such as: photonics and nano-photonics, magneto-optics and magneto-plasmonics, nanofabrication, surface chemistry and microfluidics. He is co-author of more than 50 publications, and the first author of three patents.

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