Synthesis Of Si/Si-BMNP Janus Particles For Drug Co-Administration

Ana Cazorla, Mónica Jimenez-Carretero

[1] *Department of Applied Physics, Universidad de Granada, 18071 Granada, Spain*
[2] *Department of Microbiology, Universidad de Granada, 18071 Granada, Spain*

acazagu@ugr.es

Janus particles (JPs) are colloids that break spatial symmetry by featuring two or more domains with distinct physicochemical properties. This asymmetry grants them unique versatility in biomedicine, particularly in their potential to co-administer incompatible drugs, thereby overcoming the limitations of conventional vectors.
The central objective of this work is the synthesis of hybrid JPs combining silica spheres with magnetic components. Specifically, biomimetic magnetic nanoparticles (BMNPs) are employed, consisting of magnetite (Fe_3O_4) crystals synthesized in vitro to mimic bacterial magnetosomes [1]. The synthesis is carried out via the Pickering emulsion method, allowing for the selective functionalization of a single hemisphere of the silica particle. This results in a Janus structure (Si/Si-BMNP) with one bare silica face and another coated with magnetite [2]. The inclusion of these magnetic domains is critical, as it enables remote manipulation and heat generation via magnetic hyperthermia under alternating magnetic fields. In this regard, the magneto-thermal response, assembly dynamics, and the formation of chain-like structures of the Si/Si-BMNP have been exhaustively characterized, comparing their behavior against fully coated and half-coated particles.
Finally, their application potential is studied through the simultaneous immobilization of doxorubicin and tetracycline. This design allows for the targeted and localized administration of combination therapies in damaged tissues via magnetic guidance, minimizing adverse effects in healthy areas.

Keywords:
Janus particles, Pickering emulsion, Biomimetic magnetite, Magnetic hyperthermia, Drug co-administration

References:

[1] M. Jimenez-Carretero et al. International Journal of Biological Macromolecules. 2025.
[2] A. Perro et al. Colloids and Surfaces A: Physicochemical and Engineering Aspects. 2009.

Acknowledgements:
This work has been funded by the University of Granada's Research Plan (Plan Propio de la UGR), Precompetitive Research Projects for Young Researchers – Category B (Ref. PPJIB-2024-23). A.C. thanks Grant No. PRE2022-2-101943 funded by MICIU/AEI /10.13039/501100011033 and by FSE+ for the financial support. M.J thanks Grant No. FPU21_01529.