Nature-Inspired nanocomposites enabling smart technologies

José Manuel Delgado-López, Gloria B. Ramírez-Rodríguez

Bionanomet, department of Inorganic Chemistry, University of Granada, Spain.
jmdl@ugr.es

Bone has a hierarchic structure with many levels of organization [1]. Different supra-fibrillar arrangements occur and coexist, forming dense structural hierarchies from the nanoscopic to the macroscopic length scales [1]. The building block of such a complex architecture at the atomic-namometer length scales is the mineralized collagen fibril. Over the past years, new insights into the mechanisms of bone mineralization have been reported; however, open debates still persist concerning the chemical nature of the first mineral formed; the factors controlling the initial deposition and growth of crystals; the role of the organic matrix (*i.e.* collagen, non-collageneous proteins (NCPs) and small molecules) [2]. Numerous studies were focused on exploring the role of collagen and NCPs suggesting that they may be involved in different steps of bone mineralization, such as the formation of the precursor phase(s), its further transformation into and organization of apatite crystals [2]. However, most of the above-mentioned questions still remain unanswered or at least under discussion [3].

We are interested in understanding how higher organisms produce their specialized mineralized structures, with special emphasis on elucidating the mechanisms (i.e., nucleation and crystal growth) enabling the control over the final crystal size, morphology and polymorphism. We are also keen in turning the gained knowledge into the design of novel materials with higher level of performance and new functionalities: i) collagen/mineral hybrid nanocomposites for hard tissue repair;[4] ii) CaPs nanocarriers of targeting moieties, therapeutic and imaging agents;[5] iii) fluoride-doped CaP nanoparticles for enamel remineralization.[6] Some of the latest results will be presented.

References

[1] S. Weiner, H.D. Wagner, *Annu. Rev. Mater. Sci.* **1998**, *28*, 271.
[2] A. George, A. Veis, *Chem. Rev.* **2008**, *108*, 4670.
[3] Y. Wang, T. Azaïs, M. Robin, et al., *Nat. Mater.* **2012**, *11*, 724.
[4] Ramírez-Rodríguez, G.B.; Sprio, S.; Montesi, M.; Delgado-López, J.M.; Iafisco, M.; Sandri, M.; Tampieri, A. Biomimetic mineralization of recombinant collagen type I derived protein to obtain hybrid matrices for bone regeneration. *J. Struct. Biol.* **2016**, *196*, 138–146.
[5] Delgado-López, J.M.; Iafisco, M.; Varoni, E.M.; Tampieri, A.; Rimondini, L.; Gomez-Morales, J.; Prat, M. Cell Surface Receptor Targeted Biomimetic Apatite Nanocrystals for Cancer Therapy. *Small* **2013**, *9*, 3834–3844.
[6] Iafisco, M.; Degli Esposti, L.; Ramírez-Rodríguez, G.B.; Carella, F.; Gómez-Morales, J.; Ionescu, A.C.; Brambilla, E.; Tampieri, A.; Delgado-López, J.M. Fluoride-doped amorphous calcium phosphate nanoparticles as a promising biomimetic material for dental remineralization. *Sci. Rep.* **2018**, *8*.