Estudios de RMN de estado sólido de vidrios mesoporosos: ¿qué podemos aprender sobre los procesos de mineralización in vitro de apatita?

Solid-state NMR studies of mesoporous glasses: What can we learn about apatite mineralization processes in vitro?

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Bioactive glasses are utilized for bone regeneration applications, owing to the formation of a hydroxy-carbonate apatite (HCA) surface layer when the glass is exposed to body fluids or simulated body fluids (SBF; mimicking acellular human plasma). Thanks to their mesoporous features, templated mesoporous bioactive glasses (MBGs) of the CaO–SiO2–(P2O5) system possess large surface-areas, thereby offering an excellent bioactivity (bone-bonding property) [1]. The amorphous pore-walls of P-bearing MBGs involve a main silica-rich CaO–SiO2 glass phase and nm-sized clusters of amorphous calcium orthophosphate (CaP) [2].

We will present our recent findings from in vitro studies of MBGs with different Ca/Si/P compositions, which were exposed to SBF for variable periods between 15 minutes and 30 days. Solid-state 29Si NMR experimentation allowed for monitoring the interconversion of the various silicate species at the MBG surface at the early reaction stages, whereas 31P NMR and powder X-ray diffraction (PXRD) were employed to probe the subsequent formation and evolution of the biomimetic phosphate layer; the latter initially consists of amorphous calcium phosphate (ACP) that subsequently crystallizes into nano-crystalline HCA. The relative amounts of ACP and HCA were assessed independently by PXRD and 31P NMR. The evolution of the various silicate/phosphate species during the SBF-immersion will be discussed in relation to the initial composition and concentration of the MBG in the aqueous medium [3, 4]. The complex system of co-existing MBG/ACP/HCA components also feature a wide diversity of proton environments: they were identified by

combining an array of 1H–29Si and 1H–31P heteronuclear NMR techniques that assisted the assignment of the H-signals associated with the silicate surface and the bio-mimetic ACP/HCA layer, respectively.