UNIVERSITÀ DI TRENTO
Dipartimento di Ingegneria Industriale

DII Seminar

Low temperature consolidation of metastable bioactive ceramics for biomedical applications

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Seminar room, Polo Ferrari 2, Via Sommarive 9, Trento

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Metastable (biocompatible) inorganic compounds may provide various opportunities for biomedical applications, related to their high reactivity, propensity to evolve/resorb in vivo, and the associated release of bioactive ions. They may also be combined with bioactive molecules/drugs in view of local release.
Bone-biomimetic apatites are highly relevant to biomedical applications. Contrarily to stoichiometric hydroxyapatite, they are nonstoichiometric, generally exhibiting a plate-like morphology, and present on their surface a non-apatitic hydrated ionic layer with labile ions that can take part in ion exchanges or molecular adsorptions in view of conferring additional therapeutic properties. Low temperature consolidation by Spark Plasma Sintering (SPS) allowed us, since 2005, to obtain and study cohesive 3D scaffolds of biomimetic nanocrystalline apatites despite their metastable character, while preserving their appealing hydrated and nano-dimensional features. We then showed that it was possible to add organic fibers in this case microcrystalline cellulose, to modulate the mechanical properties of the scaffolds.
Note that a full densification is generally not targeted in our experiments, with the view to keep an accessible porous network for possible subsequent drug association/release and for increasing the biodegradability rate after implantation.
Amorphous calcium phosphates (ACPs) are another family of appealing compounds for bone applications, as they are potential precursors of bone apatite in vivo and their amorphous character confers an even lower stability, leading to highly bioactive/highly resorbable bioceramics for local bone repair.
However, a key technological challenge is to process them into 3D scaffolds while retaining their amorphous character, which allows fast resorption and ion release. Again, cold sintering by low temperature SPS allowed us, in combination with carbonate/magnesium co-doping, to successfully obtain still-amorphous cohesive ACP matrices, thus opening the way to novel applications.
Finally, this presentation will address one last family of metastable compounds, namely Layered Double Hydroxides (LDHs). We adapted the developed cold sintering SPS strategy to prepare cohesive 3D monoliths of LDHs of different compositions, including Al-free.
We demonstrated then that LDH interlayer spaces remained accessible to interact with molecular species. Such metastable compounds may allow envisioning new strategies for tomorrow's medicine.

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