Antibacterial strategies applied to the design of ceramic materials for biomedical implants

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In the nearest future, a significant increase of biomedical implant demand is expected due to a dominant demographic phenomenon – ageing of population and rising of the life expectancy. Nowadays, the main requests for implants are their good osteointegration and long term stability, possibly accompanied by the host bone regeneration process. For these purposes, metallic implants are coated with biomimetic functional ceramic biomaterials substantially improving the properties of metals, creating a proper bone-material interface, and, as a result, leading to a better integration into the surrounding bone tissue. In the present investigation, recent results obtained for biomaterials possessing multiple functional properties designed as scaffolds and coatings on titanium and on biodegradable metal alloy implants will be reported. In the case of biodegradable implants, the focus point is the control of their degradation rate and their bioactivity characteristics. The developed coating materials are mainly composed of multi-substituted calcium phosphates and bioactive glass materials of innovative composition, containing trace ions with therapeutic functions, triggering the natural bone tissue response.

A crucial aspect of biomedical implants is the development of their additional antimicrobial characteristics – a challenging issue for a sustainable medical practice avoiding massive use of antibiotics. In this work, the synthesis of antimicrobial materials and the development of antimicrobial surfaces was carried out and their comprehensive characterization was performed. Their properties, such as structural, morphological, and mechanical features, wetting contact angle, behaviour in model media, etc. will be reported. The results obtained for ion doped calcium phosphate bioceramics will be demonstrated. Such materials possess a broad range of specific functional properties, from antibacterial to magnetic ones. *In vitro* bioactivity, cell and microbiology tests data focused on material-cell interactions will be reported.

The nanostructured antimicrobial materials developed in this work are promising for new strategies in tissue replacement and regeneration, ensuring required structural, chemical, morphological and mechanical characteristics and providing a controlled release of active principles, improving long term stability and performances of dental and orthopaedic medical implant devices.