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EDITED AND REVIEWED BY
Hafiz M. N. Iqbal,
Monterrey Institute of Technology and Higher Education (ITESM), Mexico

*CORRESPONDENCE
Richard Drevet,
drevet@mail.muni.cz

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Editorial: Bioactive coatings: advancing bone implant performance and longevity

Richard Drevet[1]*, Hafedh Dhiflaoui[2] and Hicham Benhayoune[3]

[1]Department of Plasma Physics and Technology, Masaryk University, Brno, Czechia, [2]Laboratoire de Mécanique Matériaux et Procédés (LMMP), Ecole Nationale Supérieure D'Ingénieurs de Tunis, Université de Tunis, Tunis, Tunisia, [3]Institut de Thermique, Mécanique et Matériaux (ITheMM), EA 7548, Université de Reims Champagne-Ardenne (URCA), Reims, France

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Editorial on the Research Topic
Bioactive coatings: advancing bone implant performance and longevity

The field of advanced thin films and coatings for bone implants is gaining significant attention due to the increasing demand for innovative solutions in orthopaedic and dental surgeries (Alluhaidan et al., 2024; Bertrand et al., 2023). As the global population ages, there is a pressing need for bone implants that not only replace or repair bone tissue functions but also possess enhanced properties and extended lifespans (Gheno et al., 2012; Li et al., 2017). These implants must exhibit specific biological, chemical, and mechanical characteristics to ensure optimal interaction with the surrounding tissues (Williams, 2022; Furko, 2025). Recent studies have focused on the development of bioactive thin films and coatings that support bone cell growth and promote a strong bond with bone tissues (Ali et al., 2021; Dhiflaoui et al., 2024; Ciobanu et al., 2025). Various deposition methods can be used to produce them (Akhtar et al., 2022; Heimann, 2024; Drevet et al., 2019).

This Research Topic aims to explore the development and application of advanced thin films and coatings to improve the osseointegration and overall performance of bone implants. The primary objectives include investigating the effectiveness of different coating methods, understanding the interaction between coatings and bone tissues, and enhancing the biological and mechanical properties of implants. Four articles have been published to present the latest achievements in the field and the next challenges to produce a new generation of innovative bioactive coatings.

In their article, Balasubramani et al. describe biocompatible composite coatings made of β-tricalcium phosphate (β-TCP), pectin, gelatine, and polyvinylpyrrolidone (PVP). They study the impact of different concentrations in each material (Balasubramani et al.). The composite coatings are deposited on a cortical titanium bone screw by dip coating. The results show enhanced biocompatibility, antibacterial properties, anti-inflammatory activities, and bone cell growth that are relevant for bone implant applications.

In another article, Lanzino et al. produced thin GB14 coatings on a titanium substrate by high velocity suspension flame spraying (HVSFS). GB14 is a calcium alkali orthophosphate ceramic ($Ca_2KNa(PO_4)_2$) deposited on titanium implants to promote bone regeneration. The authors describe the effect of different experimental parameters on the coating properties (Lanzino et al.). The optimized coatings are uniform, porous, rough, hard, biocompatible, and promote bone cell growth.

Kloster et al. studied composite coatings made of poly(ε-caprolactone) (PCL) nanofibers containing bioactive glass microparticles (Kloster et al.). These coatings are deposited by electrospinning on stainless steel wires used for bone repair. In addition, amoxicillin-loaded Eudragit® nanofibers are co-electrospun to impart a pH-selective release behavior against bacterial infection. The obtained composite coating promotes biocompatibility and osseointegration, releasing amoxicillin in a physiological environment in the pH range where infection is likely to occur.

The article by Liu et al. describes a baicalin-containing saline solution used to store titanium implants for 4 weeks (Liu et al.). They studied the impact of three different concentrations of baicalin and compared the results to those obtained for titanium stored in air or a baicalin-free solution. Baicalin is an organic compound extracted from the root of the Chinese herb named *Scutellaria baicalensis* Georgi (Labiatae), known for relevant biomedical properties. They characterized the titanium surfaces after storage and observed enhancement in the proliferation of osteoblasts due to the presence of baicalin in the storage solution.

These studies underscore the importance of continued exploration of low-temperature deposition methods to enhance the biological and mechanical properties of biomaterials. This research addresses key questions about optimizing bioactive coatings for better osseointegration, effective incorporation of organic components, and understanding how different materials and coatings influence the long-term success of bone implants. In summary, this Research Topic illustrates significant progress towards producing a new generation of innovative bioactive coatings, essential for improving the performance and longevity of bone implants. Future directions of this Research Topic include the development of multifunctional smart coatings with enhanced biocompatibility and functionality. Controlled drug release and targeted tissue regeneration are major objectives in the field with the aim of developing a personalized care plan for each patient. The next-generation of bioactive coatings deposited at low temperature will be designed to deliver therapeutic agents such as antibiotics and growth factors after implantation.

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