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# Design of active ceramic bone implants: An electromechanical conversation


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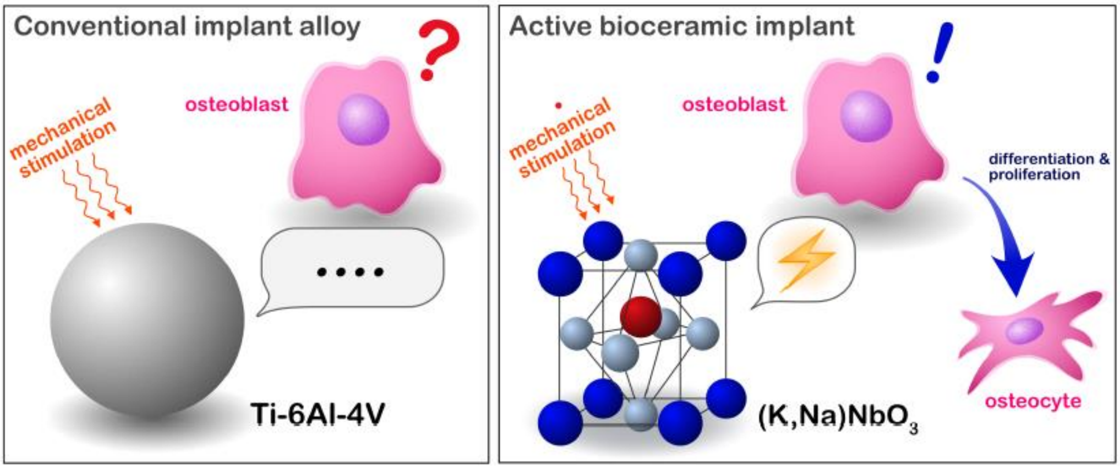
**Project:** Self-sufficient Electromechanical Implants: Enabling Piezoelectric Functionality for in vivo Devices





## Abstract

The human body relies on electric signalling for all cellular communication [1], and the application of exogenous electric fields has been shown to improve would healing, particularly in bones [2, 3, 4]. The advent of lead-free of piezoelectrics provides an opportunity to design electromechanically active biomaterials that interface with the human body, electrically communicating with cells and promoting healing. Conventional orthopaedic implants, such as titanium joint replacements, lack the electrical stimulation present in healthy bone tissue. Piezoceramics are well suited to orthopaedic applications due to their bulk mechanical properties, and present a unique possibility for advancement in the field of functional biomaterials: the ability to replace both the structure and electrochemical function of bone. Herein

we explore these functional possibilites using (K,Na)NbO3 (KNN) as a model system; a promising candidate due to its biologically similar range of electromecahnical properties and broadly non-toxic constituent ions [5, 6]. A prominent challenge in biointerfacing devices is the iterative nature of material-body interactions. Any material implanted in the body will be affected by its complex aqueous environment, applied stresses, fluid flow, and cellular responses; these factors inevitably alter the structure of an implanted bioceramic. Any alteration in structure will in turn alter the material's properties, and as the functional properties of the bioceramic are designed to influence and direct the behaviour of the body, the altered properties of the ceramic in induce altered responses of the body. This cycle of structure-property changes and body-material interactions continues for the lifetime of the implant, and it is necessary for both the safety and stability of functional implants to understand this cycle in both local and systemic environments and in immediate and long-term time scales. Using our current investigations of KNN bioceramics, this talk will showcase the breadth and depth of processing and characterisation required to design and develop a successful electrochemically active implant. Combining expertise in materials science with biology, our work in functional piezoceramics presents the excting potential of self-directed electromechanical communication with the body.

## References.

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