Chapter 8
Exploring the Electrochemical Potential of Calcium Phosphates:
From Corrosion Inhibition to Energy Storage

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ABSTRACT

Calcium phosphates are inorganic materials. They have good electrochemical properties due to their stability, low cost, and compatibility with biological systems. These features make them suitable for many applications. This chapter looks at their role in corrosion protection and explores opportunities for their use in energy storage. it includes an experimental study that compares the anticorrosive effectiveness of different calcium phosphates on carbon steel in harsh neutral and acidic environments. The results show significant inhibition rates, ranging from 87% to 92.5% in a 3% NaCl solution and exceeding 95% in acidic conditions. SEM/EDX analyses confirmed the formation of protective layers on the carbon steel surface, support-

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ing the effectiveness of these inhibitors. Lastly, it addresses some key challenges of calcium phosphates as electrode materials for energy storage and looks at future opportunities to improve performance.

1. INTRODUCTION

Calcium phosphates are one of inorganic minerals family that has been deeply studied, due to their exceptional physicochemical features. They naturally occur in biological tissues, such as teeth and bones, and for their outstanding biocompatibility, bioactivity, and ability to promote bone regeneration, they are particularly appreciated (Abouricha et al., 2024; Crespilho et al., 2025; Sane, 2017). For these features, calcium phosphates are considered reference biomaterials in the medical field and find application in controlled-release drug delivery systems, prosthesis coatings, bone substitutes, and orthopedic implants(Ballouze et al., 2021; Habraken et al., 2016; Huang et al., 2024; Hwang et al., 2012; Shadanbaz & Dias, 2012). Besides the biological applications, calcium phosphates present several interesting physico-chemical advantages, such as a modular crystal structure, good chemical stability, and possibility of ion doping(El Hallaoui et al., 2024). These features are opening the way to exciting electrochemical applications and, in particular, to chosen materials for energy storage and corrosion inhibitors(Abouricha et al., 2024; Ferraa et al., 2024; Ferraa, et al., 2025) (Figure 1). Among the innovators in the space, calcium phosphates such as hydroxyapatite ($Ca_{10}(PO_4)_6(OH)_2$), tricalcium phosphate ($Ca_9(HPO_4)(PO_4)_5(OH)$, and octacalcium phosphate $Ca_8(PO_4)_{3.5}(HPO_4)_{2.5}(OH)_{0.5}$. These compounds have the major advantage of being non-toxicity, besides the additional characteristic of forming dense adherent barriers on metallic surfaces which enable them to withstand better ionic exchange, and guard against corrosive damage in saline and acidic environments (Ferraa et al., 2024; Ouakki et al., 2018).