

The use of electrokinetic zeta potential and KPFM measurements in the functionalization of biomaterials

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The biomaterials' surface is the place where exogenous materials, physiological fluids, proteins, and cells meet determining the host response. Surface features such as chemical composition, exposed functional groups, zeta and electric potential, wettability, topography, and roughness strongly affect this response. Surface functionalization and coating with biomolecules are strategic tools to modulate surface properties and control the biomaterial outcome. The design of a functionalization process goes through the following main steps: selection of the biomolecule and process parameters, identification of the effective presence of the biomolecule on the surface and type of bond, and evaluation of the biological response.

Zeta potential titration curves as the function of pH and KPFM can help both the first and second steps. They give significant information on the surface features of the substrate and functionalization solution, allowing the selection of process parameters and speculations on the mechanism of physical or chemical adsorption. Moreover, they allow detection and imaging of the adsorbed biomolecule on the functionalized surface.

Some examples will be described: functionalization of a chemically treated titanium alloy (Ti6Al4V) with tocopherol phosphate for antibacterial purposes and with a natural extract of polyphenols from grape pomaces for osteogenic and anti-inflammatory purposes.

The role of calcium ions in the chemisorption of the biomolecules and the surface distribution of the biomolecules on the surface was evidenced by KPFM. The orientation and exposed functional groups of the biomolecules on the surface were deduced from zeta potential titration curves. Biological tests evidenced different biological responses of the functionalized surfaces according to different process parameters in terms of cytocompatibility (human mesenchymal stem cells) and antibacterial action (*Staphylococcus epidermidis*).