Bioinspired silica nanoparticle coating for titanium-based implants

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Silica nanoparticles (SiNPs) have been utilized to construct bioactive nanostructures comprising surface topographic features and bioactivity that enhance the activity of bone cells onto titanium-based implants. However, there have been no previous attempt to create microrough surfaces based on SiNP nanostructures even though microroughness is established as a characteristic that provides beneficial effects in improving the biomechaical interlocking of titanium implants. Herein, we propose a protein-based SiNP coating as an osteopromotive surface functionalization approach to create microroughness on titanium implant surfaces. A bioengineered recombinant mussel adhesive protein fused with a silica precipitating R5 peptide (R5-MAP) enables to directly control the microroughness of the surface through the multilayer assembly of SiNP nanostructures under mild conditions. The assembled SiNP nanostructure significantly enhances the *in vivo* osteogenic cellular behaviors of preosteoblasts in a roughness-dependent manner and promotes the *in vivo* bone tissue formation on a titanium implant within a calvarial defect site.