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Protein-functionalised plasma activated coatings for orthopaedic applications

The prevalence of orthopaedic implants has greatly increased worldwide. In Australia alone, for example, close to a million total hip and knee replacement operations have been performed since 1999, around 10% of which required revision surgeries due to problems associated with poor bone integration. Protein-functionalisation of titanium for load-bearing orthopaedic applications is a strategy being explored to facilitate optimal bone integration. Plasma polymerisation is a dry, versatile, and largely substrate-independent process to produce thin films suitable for protein immobilisation. In our work, we utilise a combination of plasma polymerisation and energetic ion bombardment to embed high quantities of radicals into the plasma polymerised coating for the covalent immobilisation of proteins. This novel method of protein immobilisation removes the need for further wet-chemical steps. Fibronectin (FN), osteocalcin, (OCN), a mixture of FN: OCN in a ratio of 1:3 respectively (FN:OCN), and an FN-OCN fusion protein (Fusion) were covalently immobilised onto rPPF-coated Ti substrates. Mouse primary osteoblasts (mOB) were utilised for the analysis of cell attachment (DAPI) and spreading (F-Actin) after 1 hour, and the cell mineralisation (alizarin red) after 17 days. Significant increases in both attachment (cell number) and spreading (cell size) were observed on the ratio- and the fusion -functionalised surfaces compared to bare Ti and rPPF. A significant increase in cell mineralisation was found on the fusion-functionalised surface only compared to Ti, rPPF, and OCN. We have demonstrated that multifunctional protein surfaces can be fabricated on rPPF-coated Ti substrates for improved osteoblast activity, thereby, demonstrating a potential to reduce the need for revision surgeries.

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