Development of Lanthanide glass-reinforced Hydroxyapatite composites: MG63 Cells behaviour and Antimicrobial response

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Abstract

Human skeletal bone loss and infections are major health concerns in the XXI century, with significant socio-economic implications. It is estimated, that each year around 700,000 deaths worldwide result from antimicrobial resistance. Unless action is taken, this is projected to rise to 10 million deaths each year by 2050, with the added impact of a cumulative $100 trillion of economic output at risk due to the rise of drug-resistant infections [1]. Hence, it is necessary to develop alternative antibacterial agents for healthcare. Lanthanide ions (Ln3+), also known as Rare-Earths [2] are a group of elements from lanthanum to lutetium (Z=57 to 71) and including scandium (Z=21) and Yttrium (Z=39). Lanthanides have been previously shown to display an effective antibacterial activity, and to further modulate bone metabolism, broadly due to their affinity to calcium interaction sites [3]. Inclusion of Ln3+ ion containing glasses into hydroxyapatite (HA) is expected to influence the biological response of composites by modulating the cell behaviour and simultaneously displaying an effective antibacterial activity. Previously, the authors developed work on lanthanide materials for luminescence, anti-infective and bone regenerative applications [4]. In the present work, Lanthanide-doped boro-silicate host glasses have been developed which were incorporated in the HA matrix. The developed composites were characterized *in vitro,* using human osteoblastic cell populations - for cytocompatibility assays, and *S. aureus* – the most relevant bacteria for bone tissue infection, for antibacterial efficacy evaluation. The results obtained suggested that lanthanide glass-reinforced HA composites presented enhanced osteoblastic cell response and antibacterial activity, as comparing with control samples - the two key features contributing to an improved biological outcome following bone graft implantation. **Acknowledgement:** The authors (SHN and AS) would like to thank the European Union's Horizon 2020 research and Innovation programme under the Marie Sklodowska-Curie in grant agreement No. 753636. **References:** [1] http://www.jpiamr.eu/wp-content/uploads/2014/12/AMR-Review-Paper-Tackling-a-crisis-for-the-health-and-wealth-of-nations_1-2.pdf. [2] Handbook on the 'Physics and Chemistry of Rare Earths', eds. K. A. Gschneidner, Jr & L. Eyring, Elsevier, USA, vol. 25,1998.[3] S.P. Fricker, Chem. Soc. Rev., 2006; 35(6)524. [4] N.S.Hussain, et.al, Adv. Mater. Lett., 2016; 7(9)702; & J. Mater. Chem. B, 2014; 2(35)5872.

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