Bioactive glass nanoparticles with enhanced functionalities: progress and opportunities in biomedical applications

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Bioactive glass (BG) is a versatile material for various biomedical applications including bone/soft tissue regeneration [1,2]. Their nanoscale forms, such as nanoparticles (BGN), are particularly suitable building blocks for developing nanocomposites as well as being effective platforms for drug delivery [3]. Due to the amorphous structure and tunable chemical composition, ions (e.g. Cu and Ca ions) that exhibit biological activity can be conveniently incorporated into BG [4]. Considering the small size and uniform shape, sol-gel derived BGN have shown great potential as carriers in targeted or local delivery and for the release of biologically active ions and drugs [5]. We have developed a series of sol-gel based approaches to synthesize spherical BGN for various biomedical applications. In order to incorporate metallic ions into BGN by keeping homogeneity in size and shape of the particles, different strategies, such as the Stöber method and surface modification, have been adopted in our studies. The synthesis strategy depends in each case on the metallic ion ion(s) involved. Particle size is controllable by tuning processing parameters (e.g. solvent concentration) while the porosity of particles is also tailorable through introducing pore-forming templates during sol-gel processing. Highly dispersed ion-containing BGN have been successfully produced through the developed sol-gel based approaches. The bioactivity of BGN can be retained after the incorporation of metallic ions. Furthermore, osteogenesis, angiogenesis or antibacterial activity of BGN are successfully promoted by the introduction of suitable ions (e.g. Cu and Ag ions). The developed BGN are also able to release ions in a sustained manner. These BGNs thus show great potential, usually combined with biopolymers, in applications related to tissue regeneration, drug delivery or nanomedicine.

References

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