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Sol-gel processing of bioactive glass nanoparticles: a review

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Abstract

Silicate-based bioactive glass nanoparticles (BGN) are gaining increasing attention in various biomedical applications due to their unique properties. Controlled synthesis of BGN is critical to their effective use in biomedical applications since BGN characteristics, such as morphology and composition, determining the properties of BGN, are highly related to the synthesis process. In the last decade, numerous investigations focusing on BGN synthesis have been reported. BGN can mainly be produced through the conventional melt-quench approach or by sol-gel methods. The latter approaches are drawing widespread attention, considering the convenience and versatility they offer to tune the properties of BGN. In this paper, we review the strategies of sol-gel processing of BGN, including those adopting different catalysts for initiating the hydrolysis and condensation of silicate precursors as well as those combining sol-gel chemistry with other techniques. The processes and mechanism of different synthesis approaches are introduced and discussed in detail. Considering the importance of the BGN morphology and composition to their biomedical applications, strategies put forward to control the size, shape, pore structure and composition of BGN are discussed. BGN are particularly interesting biomaterials for bone-related applications, however, they also have potential for other biomedical applications, e.g. in soft tissue regeneration/repair. Therefore, in the last part of this review, recently reported applications of BGN in soft tissue repair and wound healing are presented.

Keywords: bioactive glasses; sol-gel processing; nanoparticles; fabrication strategies; biomedical applications.