

is ground into powders and sieved for specific particle sizes. The sol-gel method uses metal alkoxides that hydrolyze and partially condensate under acidic conditions, forming a sol. The sol then transforms into a gel by polycondensation, leading to a three-dimensional porous structure. During the aging step, the gel will shrink, expelling the solvent. The gel is then dried and heat treated at temperatures lower than 800°C, to remove the organic bonds, leading to a glass structure. The sol-gel process can also be used in combination with surfactants to synthesize mesoporous bioactive glasses, which have a highly organized channel structure with pores size lower than 50 nm. This ordered mesoporous structure, which has a surface area and pore volume several times higher than traditional glasses, has been designed for drug delivery systems.

The brittle nature of glass limits the fabrication of complex solid shapes for filling bone defects for orthopedic and dental applications. Hence, bioactive glasses are used in the form of powders, granules, sintered blocks, porous scaffolds, and composites, in combination with natural or synthetic polymers. By appropriate heat treatment, glasses can crystallize, forming glass-ceramics which are mechanically stronger than the original parent glass, without losing their bioactive and osteoconductive properties.

Since the discovery of 45S5 Bioglass, an increasing number of new compositions of bioactive glasses has been developed and used in the medical field. New applications of these glasses as carriers for controlled release and localized delivery of growth factors, proteins, peptides, hormones, therapeutic drugs, and other biomolecules have been continuously developed. The addition of glass network modifiers that can alter the glass or glass-ceramic reactivity, incorporation of specific biomolecules into porous structures, surface functionalization, etc., are only a few examples of major strategies to expand the clinical applications of bioglasses.

The following sections will provide an insight into the many existing and potential applications of these fascinating materials. Existing applications that support tissue regeneration or drug delivery are discussed, providing effective treatments where none had previously existed. Some new applications and therapies are proposed and the potential for new glasses and novel applications are introduced.

## 2.2 DRUG RELEASE

One of the most common but also critical complications of bone surgery is the postoperative advent of osteomyelitis, a bacterial-related infection/inflammation of osteochondral structures which is conventionally treated by systemic administration of antibiotics (Lew and Waldvogel, 2004). This approach, however, is often less efficient than desired, and the patients might have to undergo further surgery for implant removal with additional pain and discomfort and medical costs (Lima et al., 2014). A promising solution to solve these problems is the implantation of a local drug delivery system into the defect site, in order