bioactive glass containing 5.3 mol% CeO can degrade 90% of a 1M H_2O_2 solution in 1 week. An increase in the Ce content also leads to a significant reduction of the glass bioactivity, which can be associated to the tendency of Ce to react with phosphate ions, forming an insoluble $CePO_4$ phase that inhibits the formation of calcium phosphate at the glass surface.

Different authors reported that strontium affects bone cell metabolism and influences bone remodeling by stimulating bone formation and inhibiting bone resorption. Moreover, a certain ability to reduce H_2O_2-induced apoptosis has been documented (Senkoylu et al., 2008). On this basis, strontium-containing bioactive glasses (0.1 wt% Sr, as in human bone) have been prepared in order to exploit bone stimulation and antioxidant properties of strontium (Jebahi et al., 2012). A significant increase in antioxidant cellular enzymes (superoxide dismutase, catalase, and glutathione peroxidase) and a decrease in lipid peroxidation products (thiobarbituric acid-reactive substances) have been registered after Sr-enriched bioactive glass implantation in rats, together with enhanced bone mineralization. Similarly a series of alkali-free phosphosilicate glasses containing Sr and Zn [$(36.07-x)$CaO-xSrO-$(19.24-x)$MgO-xZnO-5.61P_2O_5-38.49SiO_2-0.59CaF_2, mol%, $x=0$–10] have been produced and their antioxidant activity has been evaluated monitoring MG-63 osteoblast viability during H_2O_2 treatment (Kapoor et al., 2014). Glass compositions with Zn release of <2 ppm (24 h) and Sr release of <10 ppm (24 h) were able to enhance cell viability and reduce the effect of H_2O_2. The presence of specific concentrations of antioxidant ions can inhibit the oxidative potential of fluoride contained in the glasses. The introduction of Sr and Zn increases the glass stability in TRIS-HCl solution, while its bioactivity is maintained (Kapoor et al., 2014).

It has been reported that a silica-based bioactive glass (45% SiO_2, 3% P_2O_5, 26% CaO, 7% MgO, 15%Na_2O, 4% K_2O, mol%) has the ability to act as a radical scavenger (Cazzola et al., 2016). Glass powder showed a significant scavenging activity toward the hydroxyl ($OH^{\cdot}$) radical generated by UV photolysis of H_2O_2 in the absence of cells. The exact mechanism of this behavior is still under investigation but it can be associated with glass reactivity and surface exposure to hydroxyl groups, according to data reported on the antioxidant activity of silica hydride (Stephanson and Flanagan, 2003; Hsu et al., 2010). Similarly, an antioxidative effect has been reported for fine grain (about 5 μm size) bioglass powders (Vytrixx, Schott AG) by the evaluation of oxidized proteins and lipids in cells upon UV irradiation (Fechner, 2005).

Natural polyphenols are the most widely studied antioxidant materials in various application fields (Quideau et al., 2011). However, only limited evidence of their binding on the surface of bioactive glasses was reported. Gallic acid (GA, as model molecule for polyphenols) and polyphenols extracted from red grape skins (GPH) and green tea leaves (TPH) have been grafted onto the surface of a bioactive and antioxidant glass (Cazzola et al., 2016). A higher increase in the radical scavenging ability of the material has been registered upon GA and TPH surface functionalization.