providing additional cross-links across segments of borate in the glass network, having a greater impact than on the formation of NBO (Li et al., 2017). The formation of the NBO leads to depolymerization of the glass structure. The incorporation of 15–25 mol% Sr^{2+} into the glass network significantly increased the toughness of the glass/Ti_6Al_4V constructs. The presence of Sr^{2+} slowed the rapid dissolution of a boron-containing glass and inhibited the crystallization of ACP product to HAP (Liu et al., 2014; Hasan et al., 2015; Zhang et al., 2011). It is known that ACP is formed on the surface of bioactive glass at the initial stage of conversion in SBF. Controlled release of strontium ions from a glass can have a great potential in bone recovery and the prevention of toxic effects on the surrounding tissue. Cell damage can be induced by high concentrations of dissolution products. Pan et al. (Pan et al., 2010) reported no cytotoxic effect of extracts produced from Sr-doped borosilicate glasses, with the maximum concentration of 440 ppm B and 70 ppm Sr^{2+} ions. Cytotoxicity testing with an osteoblastic cell line (MC3T3-E1) indicated that glasses with 20 mol% and 25 mol% of Sr^{2+} promoted proliferation of osteoblast cells, while the glasses with lower Sr^{2+} contents inhibited cell growth (Li et al., 2016). The glass with 25 mol% of Sr^{2+} showed bacteriostatic effect against *S. aureus* in the short term (1–7 days) as a result of the dissolution products released. An in vitro study showed that cement composed of strontium-doped borate bioactive glass (Sr-BBG) particles and chitosan enhanced the proliferation and osteogenic differentiation of human bone marrow-derived mesenchymal stem cells (hBMSCs), rather than a similar cement without Sr (BBG) (Zhang et al., 2015b). The Sr-BBG cement showed a better characteristic than the BBG cement to regenerate bone at the implant-bone interface at 4 and 8 weeks postimplantation in a critical-sized rabbit femoral condyle defect model.

8.3.5 Rare Earth Elements-Doped Boron-Containing Bioactive Glass

Rare earth elements (REE) are promising doping ions for bioactive glasses because of their wide potential biomedical applications (Obata et al., 2012; Shruti et al., 2013; Salman et al., 2011; Costantini et al., 1997; Fan et al., 2009; Keenan et al., 2016; Deliormanl, 2015; Yazdi et al., 2017; Yazdi and Towler, 2016; Conzone and Day, 2009). They have been used directly in humans for therapy of cancer and synovitis and for diagnosis by magnetic resonance imaging, anticoagulant, and antiemetic. REE can also play a role in bone metabolic processes. They can stimulate osteogenesis because they have a positive effect on the proliferation, differentiation of primary osteoblasts, and are effective against bone desorption (Zhang et al., 2010). REE are generally considered to be of low toxicity (Bruce et al., 1963; Hirano and Suzuki, 1996). The toxicity of the ionic compounds of REE decreases with increasing atomic weight. The toxicity of REE depends on the manner of their introduction into the living organism. Intravenous introduction into the body may be most toxic, while