The remarkable advantage of the 3D printing method is that customized implants with precisely controlled architectures can be printed from CAD according to computerized tomography (CT) or magnetic resonance imaging (MRI) 3D data of patients (Pei et al., 2016; Zhao et al., 2014, 2015; Zhang et al., 2015, 2014a; Wu et al., 2013). Zhang et al. (2015) have prepared MBG modified β-tricalcium phosphate (MBG-β-TCP) scaffolds with a hierarchical pore structure and a MBG nanolayer via 3D printing and spin coating. The MBG-β-TCP scaffolds possess more excellent compressive strength and apatite-mineralization ability than the β-TCP scaffolds without the MBG nanolayer. The better in vivo new bone formation activity of the MBG-β-TCP scaffolds than the BG-β-TCP and β-TCP scaffolds suggests that the MBG nanolayer on the 3D-printed bioceramic scaffolds offers a new strategy to improve mechanical properties, osteogenesis, angiogenesis, and protein expression for bone tissue engineering applications (Zhang et al., 2015). Moreover, 3D printed Sr-MBG scaffolds with uniform interconnected macropores of ~400 μm, high porosity of ~70%, and good compressive strength of 8.67 ± 1.74 MPa have good osteogenic capability and stimulated new blood vessel formation in critical-sized rat calvarial defects within 8 weeks, indicating their excellent potential applications in bone regeneration (Zhao et al., 2015). Previous works have reported that some trace elements including strontium (Sr), zinc (Zn), magnesium (Mg), or copper (Cu) play an important role in the physicochemical and biological properties of bone implants (Zhu et al., 2011b; Wu et al., 2013; Zhang et al., 2014a). Sr can especially promote bone formation and osteoblast replication while inhibiting bone resorption by osteoclasts (Zhu et al., 2011b; Zhang et al., 2014a). Zhang et al. used a three-dimensional (3D) printing technique to fabricate strontium-containing MBG (Sr-MBG) scaffolds with uniform interconnected macropores and high porosity, as shown in Fig. 4.4 (Zhang et al., 2014a). The pore size and strut diameter of the Sr-MBG scaffolds were ~400 and 400 μm, respectively. The porosities of the MBG, 5Sr-MBG, 10Sr-MBG, and 20Sr-MBG scaffolds were estimated at $70.6 \pm 1.28\%$, $69.0 \pm 1.4\%$, $73.6 \pm 1.7\%$, and $71.8 \pm 1.6\%$, respectively (Fig. 4.4). With increasing Sr substitution, the Sr-MBG scaffolds exhibited a slower ion dissolution rate and stimulated remarkable osteoblast cell proliferation and differentiation. Moreover, Sr-MBG scaffolds can serve as a drug delivery system of DEX due to their mesoporous structure (Zhang et al., 2014a).

4.3 MBGs AS A DRUG DELIVERY SYSTEM FOR THERAPEUTIC APPLICATION

4.3.1 Drug-Loading Mechanism and Release Kinetics of MBGs

The MBGs synthesized by a combination of the sol-gel method and EISA process present ordered mesoporous structures, high specific surface area, and excellent biocompatibility, and thus they are good candidates as drug carriers