printing tubes—β-TCP scaffolds are printed. In this manner, pure β-TCP scaffolds are obtained after thorough drying and subsequent sintering at 1100°C for 3 h. The synthesized β-TCP scaffolds are then coated uniformly with MBG utilizing a spin coating technique. The MBG precursor solution was prepared using a similar protocol as in a study based on copper containing variants (Wu et al., 2013) and as described above. The resulting MBG precursor solutions are coated onto the struts of the 3D printed β-TCP scaffolds using spin-coating at 500 rpm for initial 10 s followed by 2000 rpm for 20 s. After the elapse of an overnight evaporation period, the MBG dry layers underwent consolidation via the EISA process. The MBG coating was performed a further 9 times. The samples were annealed at 650°C for 5 h after heating at the rate of 1°C min^{-1}. This yielded MBG-coated β-TCP scaffolds.

By virtue of combining 3D printed β-TCP templates with nano-mesoporous bioactive glass modification, the resulting hybrid MBG-β-TCP scaffolds were found to accommodate enhanced levels of osteogenic- and angiogenic-related gene expression. Moreover, evident key markers for osteoblastic differentiation and initial mineralization of ECM of rabbit bone marrow stromal cells (rBMSCs) such as elevated levels of ALP activity and angiogenic differentiation in the guise of increased levels of vascular endothelial growth factor (VEGF) are also upregulated. SEM images and EDS analysis post SBF immersion studies showed full surface coverage of MBG-β-TCP scaffolds with apatite crystals in contrast to pure β-TCP scaffolds. These results have proved to be elusive when 3D printing alone is applied as the technique for generating scaffolds due to limitations encountered when preparing functional nanostructures (Samuels and Flowers, 2015; An et al., 2015; Zhang et al., 2015; Lemu, 2012).

18.5.3.4 Cetyltrimethylammonium Bromide (CTAB) Template Method

In order to induce bespoke shaping of particles while simultaneously preventing their agglomeration during synthesis of MBG, the use of additives and surfactants has been advocated by some groups. The shaping of particles using the surfactant CTAB as a templating agent has been investigated of late. Fine tuning the CTAB concentrations in solution from 1 to 5 mM for example, can induce a change in particle shape in solution from a spherical to rod-like morphology (Li et al., 2015a). Another study, more importantly, reported a change in the internal particle structure by altering CTAB concentrations. Case in point being a CTAB concentration hovering around 3.5 to 6.0 mM reduced particle size from 294 to 187 nm, and a concentration of 3.5 and 4.5 mM produced hollow particles while dense particles were observed with CTAB concentrations of around 6.0 ± 0.1 mM (Hu et al., 2014). The use of CTAB along with other additives such as poly(styrene-b-acrylic acid) (Li et al., 2015b) and ethyl acetate (Liang et al., 2015) have yielded average particle sizes in the range of 250 and 180 nm, respectively. Surfactants like CTAB or P123 self-organize into micelles after they have been mixed with the sol in appropriate concentrations.