

1.4.2 Degradable Polymer-BG Coatings

In addition to polymers requiring heat treatment (like PEEK), other polymers showing good mechanical properties and antibacterial activity are available, which do not require a heat-treatment step. A fundamental study to understand BG powder suspensions for EPD of BG-polymer coatings was carried out by Cabanas-Polo and Boccaccini (2015) considering negatively charged BG particles in ethanol suspensions containing different polymers such as polyvinylpyrrolidone, polyethylenimine, polyacrylic acid, and polyvinyl alcohol (synthetic polymers), as well as natural polymers such as chitosan and alginate.

Chitosan coatings have been obtained using EPD exploiting the suitable biodegradability, biocompatibility, and antimicrobial activity of chitosan. In numerous investigations, the EPD of chitosan with BG particles has been shown to generate homogeneous coatings, which exhibit interesting properties for biomedical applications (Clavijo et al., 2016; Zhitomirsky et al., 2009; Borjas et al., 2015; Mehdipour and Afshar, 2012). The addition of acetic acid to the solution has been shown to be necessary in order to dissociate carboxylic ions and generate protons and undissociated carboxylic acid molecules. When chitosan dissolves in such solutions, amino groups dissociate and decrease the conductivity. Free ions and chitosan molecules repel each other because of the same positive charges. Dissociated protons (H^+) bind to chitosan and with increasing chitosan concentration chitosan chains start interacting with undissociated carboxylic molecules which transport charge. Thus, the conductivity of the solution increases (Clavijo et al., 2016).

The successful co-deposition of chitosan and BG was first reported by Zhitomirsky et al. in 2009 (Zhitomirsky et al., 2009). Since then, coatings of chitosan and BG have been successfully obtained by EPD on a variety of substrates and employing several solvents and additives in the EPD suspension. Table 1.1 presents a summary of chitosan-BG-based coating obtained by EPD as reported in the literature; some of the studies are further described in this section.

Borjas et al. (2015) tested the mechanical behavior of chitosan/bioactive glass coatings on a Ti substrate and found the expected hardness reduction in comparison to the substrate, but an increased viscoelastic strain and elastic relaxation provided by the coating. The addition of different ions to the coating was shown to lead to a change of the hardness as reported by Clavijo et al. (2016). Chitosan/BG coatings with the incorporation of TiO_2 particles were produced applying 1.5 V and a deposition time of 2 min on 316L substrates. The Vickers micro-hardness of the coatings showed that increasing the amount of TiO_2 particles increased the mechanical behavior without modifying the bioactive glass content, as shown in Fig. 1.5.

The electrochemical behavior of chitosan coatings was investigated by Mehdipour and Afshar (2012). Coatings of chitosan/BG on 316L substrates were studied. Porous surfaces formed because of the different mobility of agglomerated particles. Lower voltages were seen to induce weaker forces that