Abstract

This study reports the synthesis and characterization of novel incompletely condensed polyhedral oligomeric silsesquioxane derivatives (IC-POSS) functionalized with hydroxyl groups, along with an assessment of their potential applications. The motivation for this study stemmed from the increasing number of reports highlighting the unique potential of open-cage POSS architectures as precursors for further chemical modification. The use of hydrosilylation enabled efficient and selective functionalization of IC-POSS, yielding compounds with unique opportunities for subsequent modifications. The obtained diol derivatives of IC-POSS exhibit amphipathic properties, forming bifunctional systems with both hydrophilic and hydrophobic domains. On one hand, this enables the formation of dynamic ester bonds with the boronic acid moieties in the p(DMAM-2-AAPBA) copolymer, while simultaneously facilitating the effective immobilization of hydrophobic active compounds, preventing their crystallization within the polymer matrix.

Hydroxyl-functionalized derivatives, owing to their dual nature, combine the stability of the inorganic cage with the chemical reactivity of functional groups. This feature enabled their use both as dynamic elements in composite materials based on reversible ester networks, and as terminal groups for lactide polymerization, leading to the formation of stable, three-armed polylactide macrostructures, thus highlighting their potential for future studies with this class of derivatives. The obtained composite materials containing IC-POSS exhibited high homogeneity and stability, allowing for effective incorporation of the hydrophobic antifungal drug clotrimazole, and were subsequently evaluated for their antifungal activity.

Biological studies confirmed the high efficacy of the obtained composites against *Candida albicans*, both in planktonic and biofilm forms, while maintaining low cytotoxicity toward human fibroblasts. These findings indicate that hydroxyl-functionalized IC-POSS derivatives represent promising candidates for the design of advanced biomaterials and drug delivery systems, particularly in applications involving poorly water-soluble active compounds.