

Bioactive Ureasil-Polyether Membranes for Glucose Controlled Release

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Extended Abstract

Glucose can act as a nutrient to improve the survival and functionality of mesenchymal stem cells, important for bone regeneration. Materials aimed to improve tissue regeneration must have several requirements, including being biocompatible and mechanically resistant. In addition, they must favor cell adhesion and migration, promote the incorporation of bioactive molecules and/or nutrients, as well as control their release of organic-inorganic polymeric nanocomposites as ureasil-polyether-based hybrid polymeric membranes that it is able to control the release of different molecules and have good biocompatibility. The use of these materials in bone regeneration has advantages, since silica (SiO₂) has biocompatible and osteoconductive properties, and the silanol groups (Si-OH) help in the formation of bone apatite, thus favoring the increase in the bioactivity of the materials. Thus, the objective of this work was to develop a new hybrid membrane composed of a mixture of ureasil-polyether based on polypropylene oxide (PPO4000) and polyethylene oxide (PEO500) for incorporation and controlled release of glucose for future use in bone regeneration. A sol-gel method was applied for the synthesis of the hybrid membrane and a mixture of PPO4000 and PEO500 with glucose incorporation was successfully developed. Physicochemical characterization techniques such as Dynamic Mechanical Analysis (DMA) and Contact Angle Assessment were performed, as well as the evaluation of thermal properties by Differential Scanning Calorimetry (DSC), bioactivity by Scanning Electron Microscopy (SEM) and energy scattering X-ray spectroscopy (EDS), swelling assay, controlled glucose release test, and hemolysis potential test were evaluated. The results showed a glucose incorporation of 6% (w/w) in a hybrid membrane mixture of PPO4000-PEO500 50:50 (%w/w) with good uniformities and no irregular appearance. In addition, we can observe that the increase in the ureasil-PEO500 ratio in the polymeric blends increases the percentage of swelling, which can interfere with the release of glucose. The release of glucose was improved by the increase in amounts of ureasil-PEO500 in the membrane. Among the blends of precursors, the more flexible membrane (presenting the highest value of $\approx 28\%$ of deformation) was ureasil-PEO500/PPO4000 20:80 (% w/w). The results also demonstrated the nucleation of apatite suggesting the bioactivity of the membranes. It was observed that the hybrid membranes of the ureasil-polyether has good hemocompatible (less than 5% hemolysis) and the results of release test showed 70,5 % of glucose after 7 days for ureasil-PEO500/PPO4000 40:60 (% w/w). Therefore, it is concluded that ureasil-polyether membranes have great potential to be used as a glucose release system, and future application to optimize bone regeneration process.

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