Tough bioadhesive nanoparticle-incorporated gelatin-based cryogels for biomedical applications

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Introduction

Non-traditional approach for bone repair: emergence of polymeric hydrogels from various sources

- Natural proteins (e.g., fibrin, fibroin, collagen, gelatin)
- Natural polysaccharides (e.g., chitosan, hyaluronon, alginate)
- Synthetic polymers (e.g., polyethylene glycol, polyvinyl alcohol, polyacrylamide)

Disadvantages: (a) small pore size, (b) mechanically weak (natural polymers), (c) susceptible to rapid degradation

Objectives

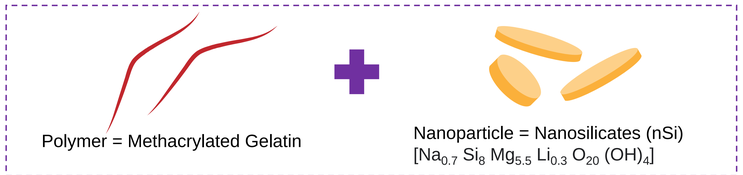
I. To prepare polymeric hydrogel scaffolds with highly porous network structure

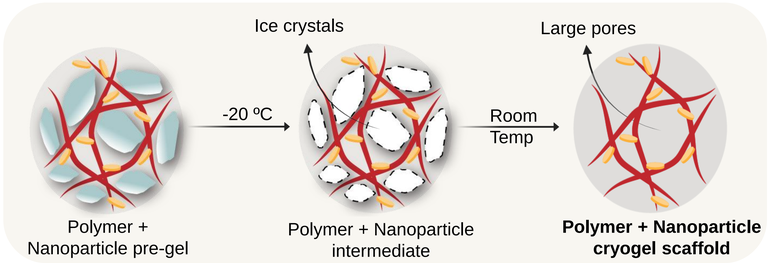
II. To improve the mechanical properties of the designed scaffold

III. To evaluate the cytocompatibility of the hydrogels with human-derived endothelial cells

III. To determine the bioactivity of a small therapeutic molecule, metformin eluted from the nanocomposite hydrogel, using human-derived endothelial cells

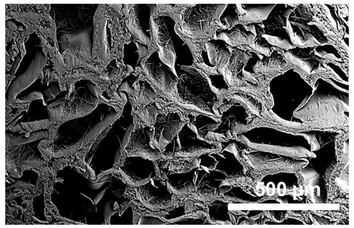
Synthesis of tough and porous polymer/nanoparticle composite hydrogel by cryogelation

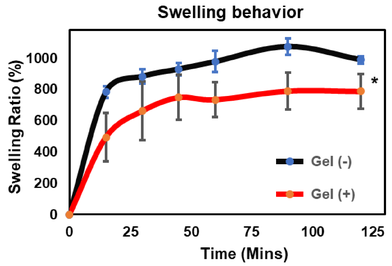


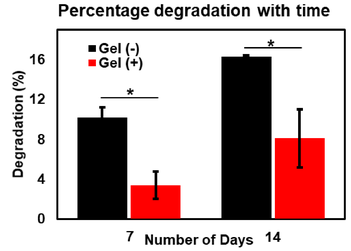


Physical characterization of the nanocomposite cryogel

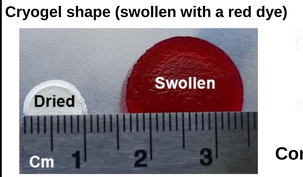
Scanning electron micrograph

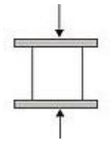


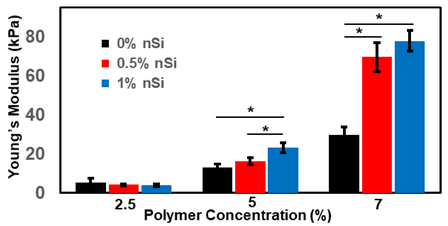


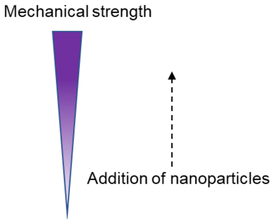


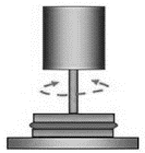
Mechanical characterization of the nanocomposite cryogel

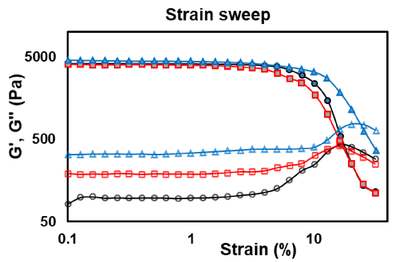


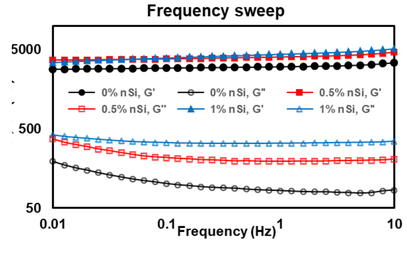




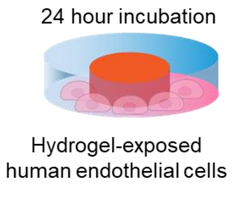


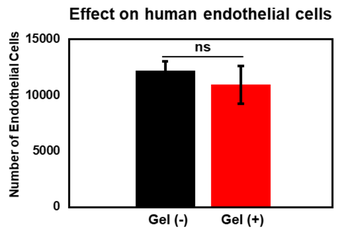




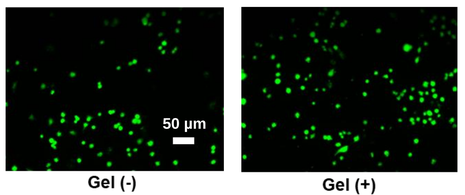


Evaluating cytocompatibility of the cryogel





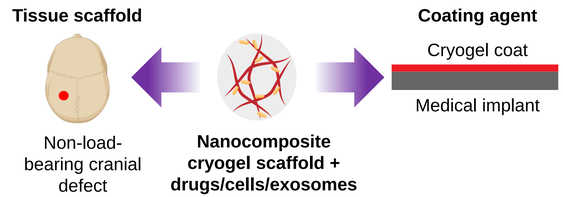
Effect of cryogel-eluted metformin on serum-starved endothelial cells



Conclusions

- The process of cryogelation produced macroporous scaffolds
- The nanosilicates increased the mechanical strength of the cryogel
- The nanosilicates reduced the degradability of the cryogel at physiological conditions
- 40% metformin released from the cryogel after 7 days
- The metformin released from the cryogel was able to reduce the detrimental impact of nutrient starvation on human-derived endothelial cells

Potential of this mechanically-robust cryogel platform for bone repair applications



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