Degradation of Hydrogel from Glycolide-Based Macromer and Polyethylene Glycol Diacrylates

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Introduction

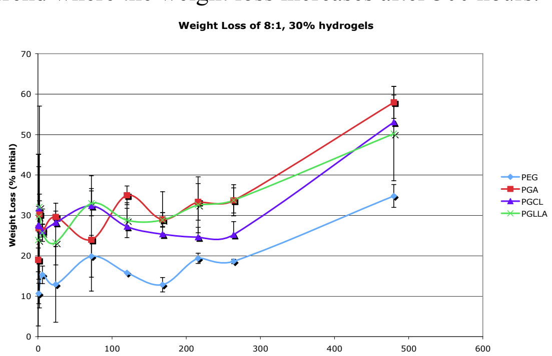
Macromer consisting of polyethylene glycol (PEG) and a degradable moiety has been used to make hydrogels as mesenchymal cells carriers for bone tissue engineering. The properties of the hydrogel are significantly affected by the type of degradable macromers used. In this project, we investigated the three different star-shape biodegradable macromers based on poly(glycolic) acid hydrogels. The effects of macromer type on the weight loss, swelling ratio, and compressive modulus of their copolymer hydrogels with PEG were investigated.

Materials and methods

Poly(glycolic) acid trimethacrylate (PGATMA), poly(glycolic acid-co-l-lactic acid) trimethacrylate (PGLLATMA), and poly(glycolide-co-caprolactone) trimethacrylate (PGCLTMA) were synthesized according to methods described by Xie et al [1]. Commercial poly(ethylene) glycol diacrylate (Monomer-Polymer & Dajac Labs, Inc. Mn=1100) was used as received. Polymer gels were prepared by dissolving 0.5 wt% photoinitiator (Irgacure 651) and an 8:1 weight ratio of PEGDA and one of the PGA based monomers in dimethylformamide to make a 30% gel solution. This was then cured by exposure to UV light and dried overnight. Pure PEGDA was used as a control. The samples were soaked in PBS and the weight loss and swelling ratio at 1, 3, 5, 7, 9, 11 and 20 days were measured in triplicates. The compressive modulus was also measured using a Chatillon MTS machine. The samples were displaced to 20% strain at a rate of 0.05 mm/s. The modulus was then calculated as the slope of the linear portion of a curve of stress vs. $-(\lambda-\lambda^{-2})$ where λ is the extension ratio.

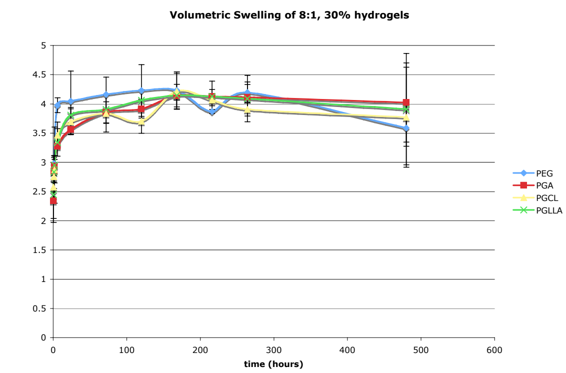
Results and Discussion

From the weight loss data at 24 hours we estimated the conversion rate of monomers were between 70-87%. In the weight loss study, all of the polymer blends show a similar trend where the weight loss increases after 300 hours.

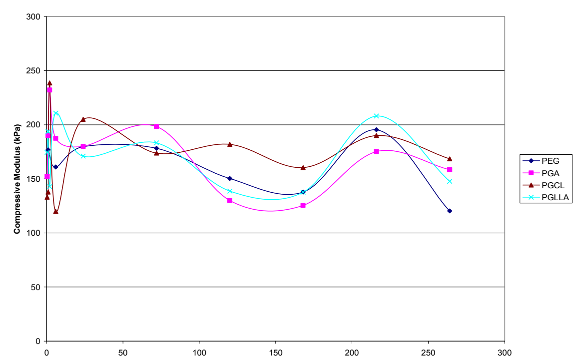


At 20 days, the weight losses for the three experimental groups were between 50-57%, with PGATMA being the highest. Weight loss at longer time points are now being collected. The result also shows that there were no statistical differences among the gels made from the three biodegradable macromers. This may be due to the small amount of macromer used in the system (11%).

Each of the copolymer hydrogels had much the same behavior when examining the swelling ratio, Q. The majority of the swelling occurred in the first day where the hydrogels swelled to approximately four times their initial dry weight. The swelling ratio became hard to measure at day 20 since the gel at that point became very fragile and hard to handle.



The compressive modulus of each hydrogel formulation remains in the range of 120-200 kPa over the period of 11 days. The modulus at Day 20 is now being collected.



Conclusion

The starting macromers does not have significant effect on the degradation rate in their copolymer hydrogel with PEG in the timeframe we have tested. Cell culture with these gels modified with Acryl-PEG-RGD will be evaluated next.

Reference

[1] Xie et al. J. Appl. Polym. Sci. 2006, *in press*