Synthesis and Degradation of Poly(β-amino ester) Fibers

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Statement of Purpose

Major initial factors influencing myogenesis include promotion of neovascularization and allowing macrophages access to the site of the wound.[1] Hydrogels, such as poly(β-amino ester) (PBAE), have tunable degradation properties and the ability to achieve multiphase drug release.[2]

The overall purpose of this project is to develop a method to polymerize PBAE into fibers that can be inserted into a matrix. As the fibers degrade in the matrix, bioactive agents are released and cells can grow into the hollowed tunnels left behind, which can promote neovascularization. In the present studies, methods for creating degradable PBAE fibers with controlled diameter were developed, and their degradation patterns were studied in *in vitro*.

Methods

Macromer was synthesized from poly(ethylene glycol) diacrylate (H) and isobutylamine (6) with a 1.2:1 molar ratio of total diacrylate to amine. After the H6 macromer was synthesized, it was prepared for polymerization. H6 macromer was pipetted into a 6 mL tube, along with 10 wt% of dichloromethane and 1 wt% 2,2-dimethyl-2-phenylacetophenone. The 6 mL tube was vortexed for 30 seconds.

To enable oil-in-water emulsion, a surfactant of 1.5% polyvinyl alcohol in deionized water was added to a large petri dish and stirred at 150, 221, or 228 rpm with a 2.5 cm stir bar. The prepared macromer was loaded into a 5 mL syringe with a 20-gauge needle that was attached to rubber tubing that was covered in foil to prevent UV polymerization inside the tubing. A UV lamp was fixed 4 in away from the spinning surfactant solution. Using a syringe pump, macromer was injected into the surfactant at a rate of 20 mL/hr. Once all of the macromer was in the surfactant solution, the UV lamp was fixed 1 in above the surfactant solution for 1 min. Afterward, fibers were transferred with forceps into a petri dish and washed overnight with ethanol to remove unreacted macromer from the fibers. The fibers were then air dried at room temperature.

The dried H6 fibers were placed in 7 mL of phosphate-buffered saline (PBS), pH 7.4, and gently shaken at 37°C. At selected time points the fibers were photographed with a microscope (Figure 1) and sized with a micrometer. The diameters of the fibers were recorded at each time point (Figure 2).

Results

The 150 rpm H6 fibers absorbed PBS for the first 1.5 hours of incubation before starting to decrease in diameter. The 221 and 228 rpm H6 fibers' diameters decreased, slightly increased, and then steadily decreased. After two hours of degradation, some fibers from the 221 and 228 rpm conditions were fully degraded. Observations also revealed that some fibers lost their cylindrical shape and flattened out during degradation, potentially increasing the diameters of some fibers. Some fibers also split into multiple pieces during degradation.

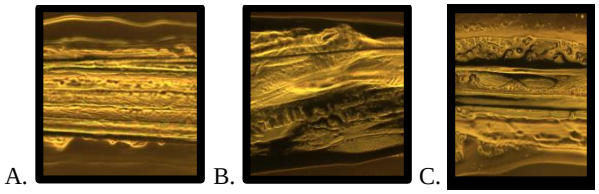

Figure 1. Image from microscope of fibers before degradation. A. 150 rpm B. 221 rpm C. 228 rpm.

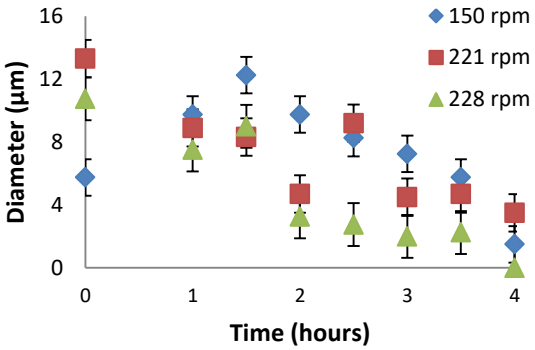

Figure 2. Average diameters of H6 fibers during degradation (mean ± standard error).

Conclusions

A method for preparing H6 fibers was developed and degradation patterns were recorded per spin rate. PBAE fibers developed with this method have tunable degradation properties based on stir bar spin rate along with macromer used and may be inserted into a matrix as a porogen to achieve a desired therapeutic effect. Future work includes studying the degradation patterns of quick degrading PBAE fibers embedded in a slow degrading PBAE matrix.

References

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Acknowledgement

This research was funded in part by the NIH (AR060964)