Effects of Temperature on *In Vitro* Degradation Behavior of a Poly(glycolide-*co*-L-lactide) Monofilament

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INTRODUCTION

Understanding of the degradation mechanism and the factors affecting them will help to design better degradable biomaterials and therefore make medical devices of superior performance. In the past few years, this lab has been investigating the *in vitro* degradation behaviors of poly(glycolide-co-L-lactide)-based biomaterials.[1-3] This presentation reports the results on the effects of temperature on *in vitro* degradation of a biodegradable monofilament fiber.

MATERIALS AND METHODS

The experimental materials were an in-house prepared drawn monofilament fiber, based on a copolymer of ~90 mol% glycolide and ~10 mol% L-lactide (PGL 90/10). The filament was annealed to give a crystallinity of 37%. Before degradation, the polymer samples had a weight average molecular weight (M_w) of 52200, a diameter of 8.7 mil and a tensile breaking strength of 90.4 kpsi. The fibers were cut into 10-in long specimens. Phosphate buffer solution (PBS) of pH 7.4 was prepared from phosphate buffer GAL-PAC (Sigma Scientific, USA). Specimens were hung on a rack and placed in PBS kept at constant temperatures (27.5, 32.5, 37.5 or 47.5°C). At each pre-determined time period, 5 specimens were removed from the *in vitro* bath and tensile-tested at room temperature immediately on an Instron tester with gage length 3.15 in and crosshead speed 5 in/min. Then, molecular weight was determined by gel permeation chromatography analysis on a Waters Modular GPC analyzer with PMMA standards.

RESULTS AND DISCUSSION

Figure 1 shows the changes of M_w with *in vitro* time and temperature. The M_w decreased with increasing exposure time. It is clear that temperature had a significant effect on the degradation time as the elevated temperature greatly accelerated the polymer degradation. Figure 2 shows the change of percent tensile breaking strength retention (BSR) as a function of *in vitro* time and temperature. Again, temperature had significant effect on BSR. Quantitatively, it would take more than 45 days at 27.5°C to reduce the remaining fiber strength to less than 10%; however, at 37.5°C, the filament lost most of its strength after 16 days. And, when temperature was raised to 47.5°C, it would need only 5 days to achieve the same amount of strength reduction. The dependence of degradation time on temperature was further analyzed as shown in Figure 3. This figure shows the *in vitro* time (t) needed to reach a certain BSR at a given temperature (T). Such relationship could be illustrated by an Arrhenius-type equation, $\ln t = C - E_a/RT$, where C=constant, E_a=activation energy, and R=gas constant. From experimental data, E_a was found to be from 87.3 to 92.3 kJ/mol. By plotting BSR against M_w, a good relationship was found, as shown in Figure 4. This relationship can be described well by the formula $BSR = a + b\ln M_w$, where a and b are constants. So, from this equation, BSR can be predicted from M_w for the fibers during *in vitro* degradation.

SUMMARY

The effects of temperature on *in vitro* degradation of a PGL 90/10 monofilament were investigated. Dependence of the *in vitro* time on temperature could be described by an Arrhenius-type equation. The study indicates that there exists a relationship between the strength and the molecular weight of these absorbable polyester monofilament fibers during *in vitro* degradation.

REFERENCES

1. Biomaterials, 26, p4327 (2005).
2. Society for Biomaterials Meeting, p68 (2005).
3. Society for Biomaterials Meeting, p511 (2005).

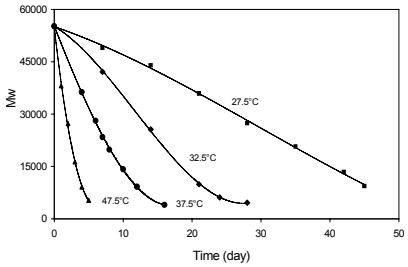

Fig 1. Molecular weight as a function of temperature and in vitro time

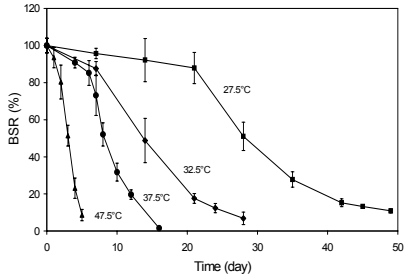

Fig 2. Dependence of BSR on temperature and in vitro time

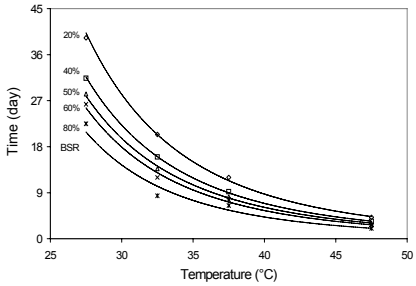

Fig 3. Effects of temperature on in vitro degradation time

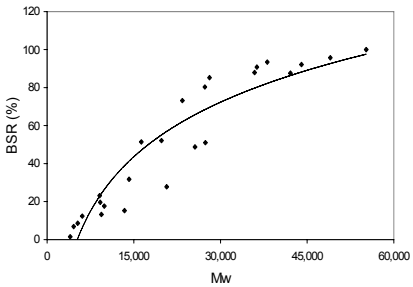

Fig 4. Relationship between molecular weight and BSR