HYDROLYTIC DEGRADATION OF PLLA AND PLGA WITH SURFACE MODIFIED BY CO_2 LASER – PRELIMINARY STUDY

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Introduction

Biodegradation of the polymeric medical devices is relevant from the application point of view. For some function not only the adequate shape plays important role but also behaviour of the device during the implementation time. In order to adjust degradation in specific areas surface modification of materials are performed [1-4].
In order to determinate influence of the laser irradiation on the hydrolytic degradation of polymer 3 group of materials, $PLLA_{AMO}$, $PLLA_{CRY}$, PLGA with surface irradiated with CO_2 laser of different powers, were incubated for 5 weeks. The aim of the study was to investigate the differences in mechanical properties of the biopolymers after degradation time in relation to the analysed material and used laser power.

Materials and Methods

The polymer sheets having an average thickness of 300-400 μm were extruded from commercial medical poly(L-lactide) (PLLA Evonik L210S) and poly (L-lactide-co-glycolide) (PLGA, Evonik LG857s) by compression molding of the granules pre-heated up to 200°C. In order to prevent material adhesion to the mold half polyamide spacer were used (Kapton HPP-ST, thickness 127 μm). This procedure allowed to obtained amorphous poly(L-lactide) ($PLLA_{AMO}$) sheds having the degree of crystallinity Xc ≈ 2%. The crystalline polymer ($PLLA_{CRY}$) was obtained from amorphous specimens which underwent thermal crystallization process for 5h in 100°C.
In order to investigate the influence of the CO_2 laser surface modification on the hydrolytic degradation of the polymer specimens were irritated with two laser powers P_1=24mJ/cm^2 and P_2=71mJ/cm^2. All samples were placed in demineralized water and incubated in 37°C for 5 weeks. Finally the mechanical properties of the specimens were determined in tensile test [5]. The stress-strain curves were determined and on the basis of obtained curves the tensile strength R_m and Young's modulus were calculated.

Results and Discussion

Presented preliminary study intend to determinate the behaviour of the most common biopolymers irradiated with CO_2 laser under hydrolytic degradation in relation to mechanical properties. From analysed materials laser beam had the strongest impact on PLGA for which decrease in tensile strength R_m average of 20% and 80% respectively for laser power 24 mJ/cm^2 and 71 mJ/cm^2 was observed. Moreover Young's modulus E decreases up to 45% with higher laser power.
In the case of PLLA, depending on its crystallization form CO_2 laser causes deferent effects on polymer. For amorphous poly(L-lactide) with the increase of laser power the decrease of 10-45% in tensile strength R_m and decrease of 5-37% in Young's module were observed.

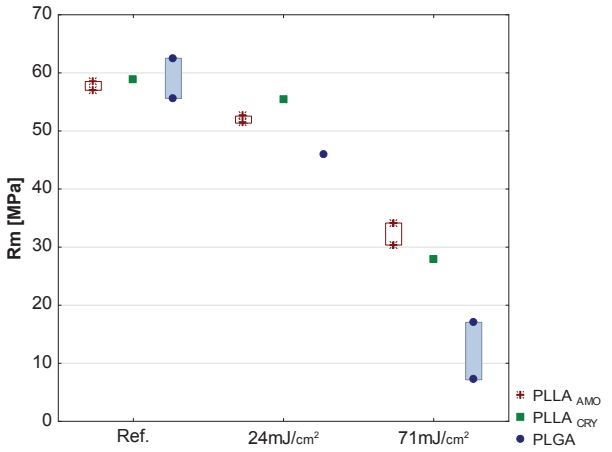

FIG. 1. The tensile strength R_m [MPa] of the biodegradable polymers, $PLLA_{AMO}$, $PLLA_{CRY}$ and PLGA irradiated by CO_2 laser of two powers.

The crystalline form of PLLA shown dual response on CO_2 laser irradiation. For power 24 mJ/cm^2 the 5% decrease of R_m with 18% increase of Young's was noticed. However for power 71 mJ/cm^2 tensile strength reduce to half while Young's modulus is similar to reference material $PLLA_{CRY}$.

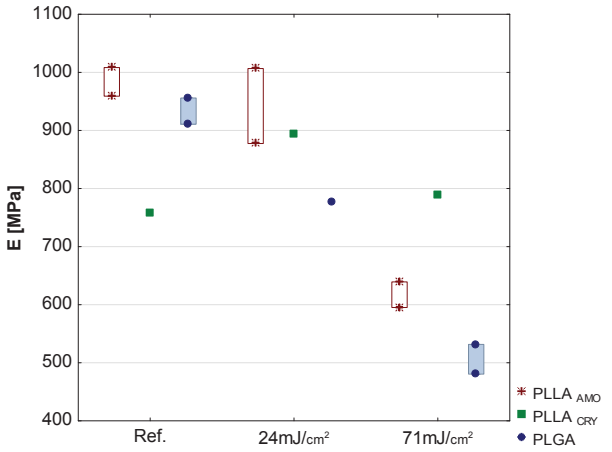

FIG. 2. The Young's modulus E [MPa] of the biodegradable polymers, $PLLA_{AMO}$, $PLLA_{CRY}$ and PLGA irradiated by CO_2 laser of two powers.

Conclusions

Conducted investigation aimed to show the changes in hydrolytic degradation of various material modified by the CO_2 laser. Study reviled the relationship between the degradation rate and the increasing power of the laser. Moreover laser beam has stronger influence on the PLGA than PLLA, regardless the crystallisation form, what can be noticed in grater decrease of mechanical properties. Preliminary study were crucial in order to determinate the rate of degradation and plan efficient long-term experiment.

Acknowledgments

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