



OPPONENT OPINION

Ing. Pavel Kucharczyk

Preparation and modification of biodegradable polyesters for medical applications

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Ing Pavel Kucharczyk has prepared his PhD thesis with title of „Preparation and modification of biodegradable polyesters for medical applications”. The field of the PhD acting is very actual because there are quite big efforts to replacing petroleum based polymers with biodegradable plastics obtained from renewable source both in the EU and Worldwide. On the other hand the increasing ratio of biodegradable polymer application is significantly higher than that of petroleum based polymers. Nowadays approximately 1.5 million tonnes of biodegradable polymers are produced and according to forecasts this amount will be reached the 4.0 million tonnes at 2020. Especially significant increasing in lactic acid and starch based biopolymer production is predicted.

Main aims of the PhD doctoral study were the developing of new synthesis routes for preparation and modification of lactic acid based polymers. The author among others developed and optimized synthesis methods for PLA production using non-metallic catalysts, functionalized the structure of PLA, and investigated the possibility of molecular weight increasing of PLA. The biodegradability of synthesized modified PLA structure was also investigated, especially under various conditions simulating the human body. Ing Pavel Kucharczyk described the possible reasons and state correlations between reaction conditions and properties of end products.

The structure of the PhD thesis is logical. Author gave an excellent summary about the types, properties, synthesis and current trends of biodegradable polyesters in the theoretical background. My opinion is that the value of theoretical background could be increased by the addition of details/brief summary about the production data of biodegradable polymers (especially polyesters), industrial trends, main companies in biopolymer production and biopolymer prices. I have no found information about the additives, which are potentially used for biopolymers. How affect the potentially used additives to the biodegradability?

The author attached four referred papers to the thesis. Each scientific paper has impacted and the summarized impact factor was 6.106. Different modern analytical methods and advanced synthesis ways were applied during experimental work; furthermore it was connected to different domestic and international projects, which significantly increased the value of PhD thesis.

The first publication described the synthesis of PLA using non-metallic catalyst. Fundamentally the effect of the reaction temperature, the concentration of methanolsulfonic acid (MSA) and the reaction time to the polycondensation reactions were investigated. According to results the best result was given using 0.5% MSA, 15kPa pressure, 24 h reaction time and 160°C or 0.5% MSA, 15kPa pressure, 18 h reaction time and 175°C. Author managed to prepare PLA having low molecular weight, which would have advantageous properties as drug deliver following copolymerization.

The possibility of PLA modification by citric acid was investigated in the second paper. The structure of modified polymer has been followed by GPC, HNMR, DSC, FTIR and classic analytical methods. It was concluded that the polymer structure could be significantly modified by the addition of citric acid. Significant reduction in molecular weight of polycondensation reaction products was found by adding of citric acid, and the thermal behaviour showed that product posses semi-crystalline structure. Higher citric acid concentration led to higher possibility of termination reactions.

The third paper was dedicated to the evaluation of effect of different catalysts on PLA solid-state polymerization, using 0.5%, 1.0% and 2.0% catalyst concentrations. According to results methanesulfonic acid showed the best properties during PLA post-polycondensation reactions, because the best balance between molecular weight and thermal stability of products was resulted in the presence of methanesulfonic acid as catalyst.

The degradation of PLA samples in different environment simulating the human body (high humidity environment and buffered liquid (pH=7.4) environment) was described in the fourth publication. Regarding degradation behaviour of PLA samples significant differences was found. Higher reduction in weight of samples was found using buffered liquid environment, than high humidity environment, and results obtained can be used for modelling of PLA degradation on different areas of human body.

Regarding experimental work I have some short questions:

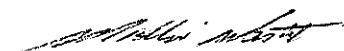
Please specify some possibilities for PLA application besides medical application.

What chemicals could be used for PLA modification instead of citric acid?

What does author think about the possibility of industrial application of investigated ways for PLA modification? What should be difficulties, possibilities or strength?

My summarized opinion is that the PhD thesis is well edited work, which contains valuable information for further PLA development for medical application. Nevertheless modern synthesis routes and analytical methods were used and the evaluations of results were correct. I recommend Ing Pavel Kucharczyk for the award of Ph.D. degree.

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