

Faculty of Technology  
Dept. of Science and Research  
Tomas Bata University in Zlin  
Nám. TGM 275

**76272 Zlin**  
**Czech Republic**



Research & Development  
Prof. Dr. Jorge Lacayo-Pineda  
MSE Expert Field Materials Evaluation  
Tel.: +49 511 976 4523  
Fax: +49 511 976 3652  
E-Mail: jorge.lacayo-pineda@conti.de

Honorary Professor  
Institute of Inorganic Chemistry  
Leibniz University of Hanover

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**Expert opinion on the Ph.D. thesis “Rheology and Processing of Medical Grade Polymeric Systems” by Ing. Martina Polášková**

Medical grade polymers are a current research topic in polymer sciences since they are essential for a high quality of life with an aging global population, and in order to support the advances in medical science to restore human health after injuries or sickness. If properly chosen for the specific application, the remarkable properties of these polymers are chemically related with their organic nature, just as bio-organic human tissue. With today's possibilities of materials engineering, polymers provide tailor-made properties like chemical resistance, bio-organic compatibility, mechanical stability, low weight, antibacterial effects, but their easy processability remains an important issue. The aforementioned remarkable properties are to be achieved in an efficient way fulfilling the financial demands of a growing market. Each new development in medical sciences grounds the need for a new selection of materials and their appropriate processing. Meanwhile, legal regulations in the European Union are increasing the pressure on the producers of medical devices in order to guarantee a minimum exposure of chemical additives needed for optimizing both the processing and the properties of medical grade polymers.

The presented doctoral thesis deals with the current topics mentioned above. The author, Martina Polášková, presents in this thesis modifications of both composition and processing of different medical grade polymeric systems with the aim of optimizing four key properties: mechanical stability, reduction of exposure to chemical additives, controlled release of antibacterial agents, and radiopacity for localization of implants. For this purpose, synthetic polymers frequently used in medical sciences were selected as well as their blends: polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), thermoplastic polyurethane (TPU). The specific goals of the work are well described in the aims formulated in this thesis.

The thesis is well structured, carefully formulated and contains valuable scientific information. The results of this work were presented at several international conferences and published in renowned scientific journals. Four original papers of the author are enclosed.

The chapters Introduction and State of the Art give a good overview of the framework of the thesis within polymer sciences and its links to the requirements for the respective applications in medical sciences. Accordingly, the polymer systems selected as appropriate materials for the experimental work are well described as well as their processing technology. The graphical overview given in table 1 is useful for presentation purposes, but more detailed technical information about sterilization and application of synthetic polymers in medicine would have been valuable to emphasize the importance of the proper selection of polymers for specific applications.

The discussion about polymer blending and compounding proves the author's deep understanding of the role of composition and processing on the morphology of a polymer blend. The importance of the morphology of fillers embedded in the polymer matrix is well described. Both blend and filler morphologies as well as their distribution determine the macroscopic properties. The author's clear comprehension of these structure-property relationships becomes evident in the discussions of the different effects documented in the papers enclosed, while these themes are often contradictory and confusingly discussed by other authors.

Based on this comprehension, the blend morphologies of PE/PP blends at specific ratios were influenced by extrusion in order to improve the mechanical properties of the samples. Micro-fibrils of PP are capable of reinforcing the PE matrix when produced by continuous extrusion with a semihyperbolic-converging die. This innovative processing solution could help to extend the range of application of PE by reinforcing it with micro-fibrillar PP structures. The experimental characterization of the blends necessary to demonstrate the effects was broad and appropriate.

The second item described by the author in this thesis demonstrates experimental skills and creativity. Since the use of PVC requires softeners as chemical additives, specifically di(2-ethylhexyl phthalate) known as DEHP, a polymer system TPU/PVC/TPU was created by co-extrusion in order to reduce the migration of the softener. The effect of the TPU coating on the PVC surface was experimentally proven with the appropriate analytical tools. The retardation efficiency for the DEHP emission was shown with regard to the reference materials (uncoated) as well as a function of the TPU layer thickness. In order to round up the discussion of results, the existing data could be analyzed in terms of permeation coefficients of both coated and uncoated samples. Furthermore the solubility of DEHP in TPU could have been explicitly analyzed and compared to that in PVC.

Moreover, the author includes in this thesis two different innovative applications for fillers in polymer technology: first, as carrier of antibacterial agents, and second, as additive for radiopacity. In the first case, the layered structure of Montmorillonite was used to intercalate the antibacterial agent Cristal Violet to regulate its release. In the second case bismuth oxychloride was used as radiopaque filler in comparison to the conventional filler barium sulfate. In both cases the expected results were achieved without considerable degradation of the matrix properties. Thus, alternative ways for medical applications were herewith delivered.

The doctoral thesis of Martina Polášková clearly demonstrates her capability for scientific research as well as her ability to apply the scientific knowledge gained during her studies to extend the state of the art in polymer sciences.

I recommend the acceptance of the presented doctoral thesis to the Faculty of Technology of the Tomas Bata University in Zlin.



Prof. Dr. Jorge Lacayo-Pineda