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Expert opinion on the Ph.D. thesis:

**“CONTROLLING INNOVATIVE POLYOLEFIN PROPERTIES BY
STRUCTURAL TRANSFORMATIONS” by Lenka Chvátalová**

The presented doctoral thesis deals with two of the principal polymers among the polyalkenes: polypropylene and polybutene-1. Both polymers are used for a wide range of applications. Their properties are known to be influenced by the specific polymer microstructure, processing, and thermal history determining the formation of a specific morphology. The author, Lenka Chvátalová, concentrates her attention on finding structure-property correlations in order to systematically understand the role of morphology in defining the final materials properties of the polymers mentioned above.

The first part of the work deals with the nucleation of the β -modification of polypropylene using the nucleation agent N,N'-dicyclohexylnaphthalene-2,6-dicarboxamide. The influences of thermal history, and molecular weight on the β -specific nucleation were investigated by wide-angle X-ray scattering, differential scanning calorimetry, and scanning electron microscopy. The consistency of the results obtained with the different techniques as well as their interpretation demonstrates the author's experimental skills and her knowledge of polymer sciences.

The β -phase of polypropylene shows spherulites with a radial symmetry, while the spherulites of the α -phase form a so-called “cross-hatched” structure. The birefringence properties of the two phases allow their differentiation by means of polarized light microscopy. It would have been helpful to quantify or at least document the nucleation effects by this simple technique.

The second, more extensive part of this doctoral thesis concerns different aspects of structure-property interrelations in polybutene-1. The properties investigated are related to important practical issues that affect the wide use of polybutene-1 as commodity polymer: the phase transition (II \rightarrow I), which influences both mechanical properties and processing time, and the UV-photodegradation, which is important for the product lifetime. Additionally, a study of the influence of plasma treatment on its hydrophobicity of the surface is presented.

For the evaluation of the influence of annealing on the phase transition mentioned above and for the characterization of the degradation behavior of polybutene-1, extensive experimental work was performed: wide-angle X-ray scattering, tensile testing, rheological testing, Fourier transformed infra-red spectroscopy, and thermal analysis. All experiments show again the candidate's high level of skills. The results obtained are conclusive and valuable.

The latter aspect, surface treatment with plasma, is discussed in a submitted paper that has not yet reached the final stage for publication. While the results are conclusive, minor changes in the data evaluation are recommended in order to increase the quality of the paper.

The modified surface of polybutene-1 was characterized by contact angle measurements, X-ray photoelectron spectroscopy, and atomic force microscopy. The experimental data presented are valuable. The conclusions regarding the use of plasma for modifying the surface of polybutene-1 in order to change the hydrophobicity are satisfactory from a practical point of view.

For the evaluation of the hydrophobicity, the so-called “sessile drop technique” was applied for which the contact angle is a premise, but not the final output. The result of sessile drop technique is actually the measure of the surface energy that can be further separated into its dispersive and polar parts according to commonly accepted models. This evaluation is missing.

The author excludes roughness as a cause of changes in the contact angles before and after plasma treatment based on single AFM images. For roughness evaluation, histograms of the gray values of these images are used. The standardized descriptors for roughness should be applied instead. Desorption of reactive groups in-vacuo during the XPS experiments should be discussed in more detail. An independent method might be used to exclude desorption as a cause of the missing changes in surface chemistry.

In general, the thesis is structured and carefully formulated. It contains valuable scientific information. The specific goals of the work are well described in the aims formulated in this thesis. The results of this work were presented at several international conferences and published in renowned scientific journals. Three original papers of the author as well as one submitted paper are enclosed.

The doctoral thesis of Lenka Chvátalová demonstrates her capability of 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

ANNEX: Tasks for the Ph.D. candidate

1. Explain the birefringence effects of the α - and β -phases of polypropylene.
2. Explain the international standard values for the evaluation of roughness.
3. Explain the difference between dispersive and polar parts of the surface energy. What are the differences in the theoretical models, e.g. Owen/Wendt, Fowkes, and Wu?