**Reviewer's Report on PhD Dissertation Thesis**

**"Application of Plasma Modified Polyethylene in Composites with Natural Materials"**

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The topic of the thesis is up to date, polymer composites reinforced with natural fibres having been intensively studied during the last years worldwide, and plasma modification of polyethylene powder has recently attracted much interest because of new prospects to control the interfacial properties treatment.

The dissertation deals with the applications of plasma modified polyethylene powder in combination with natural materials. Plasma modified polyethylene has been used both as a matrix of the natural fibre composites and a filler of the natural rubber composites. Plasma surface modification makes the polymer more polar and active, which increases its adhesion with other polar materials.

The work is well arranged. It consists of an introduction, a theoretical part, the goals of the work, an overview of used experimental methods, results and discussion as well as conclusions and future works. At the end of the work, there are all the obligatory parts as Bibliography, Authors publications, List of the tables, List of the figures and List of the abbreviations. The theoretical principles as well as the research part were validated with 90 valuable references.

In the first chapter "Introduction", the author outlines the issue of plasma treatment of polymers as an effective, economic and environment friendly method, and the issue of thermoplastic bio composites with natural fibres as eco-friendly materials. In the "Theoretical part", the basic questions of polymer composites and processing techniques are discussed in detail. Special attention is paid to coir fibre and the way of chemical treatment of its surface. In her work, the PhD candidate draws mainly on the recent literature. In the next part, the five goals of the dissertation were set: 1. The investigation of the effect of plasma modified PE as a filler in natural rubber composites, 2. The investigation of the effect of plasma modified PE as a matrix for natural fibre composites, 3. The investigation of the effect of

chemical modification of coir fibre in plasma modified PE based composites, 4. The development and optimization of plasma modified PE natural fibre composites for rotational moulding, 5. Initial studies on injection moulded natural fibre composites. The chapter „Materials and Experimental Techniques“ briefly describes the experimental methods used. The methods used were well chosen and applied correctly in the practical part of the dissertation. However, there is no description for the impact strength measurement, which is being evaluated in the further text.

Above all, I highly appreciate the large range of the results achieved, which are treated in detail in the thesis in part of “Results and Discussion”. The effect of plasma modification on polyethylene powder was proved by contact angle measurements and FTIR spectroscopy. The results indicate that plasma treated polyethylene with polar groups on the surface is not suitable as a filler for natural rubber compounds. On the other hand, plasma modified polyethylene as a matrix of coir fibre composites showed positive results. The chemical treatment of coir fibre surface caused further improvements of fibre-matrix interface. These results bring new theoretical knowledge in the field of plasma modified polyethylene based composites with natural materials.

The practical benefit of the work has been demonstrated by the verification of the suitability of plasma modified polyethylene in the preparation of coir composites using three practical technological processes (Injection moulding, Rotational moulding and Compression moulding). Coir fibre composite based on plasma modified polyethylene matrix and 5 wt % of chemical treated fibre prepared via compression moulding; almost twice tensile strength was achieved compared to other coir fibre composites tested. Also tensile and flexural moduli of this composite showed higher values. Morphology of the composites reveals that there is a good interfacial interaction between coir fibre and plasma modified polyethylene matrix. It was also proved that both plasma modifications of polyethylene matrix and chemical treatment of coir fibre have positive effects on the resistance to water absorption. For other processing methods as rotational moulding and injection moulding, the increasing of mechanical properties was not so pronounced.

It is clear that the objectives of the dissertation have been met. The candidate has demonstrated that she has mastered modern scientific methods in both plastic processing technology and the preparation and evaluation of composite materials.

There are only a few remarks and questions remaining, which occurred to me and need to be explained in details

1. On page 29, you write that plasma modified polyethylene was treated by microwave discharge under the pressure of 70 – 100 Pa and that this is descripted in detail in literature [57]. However, literature [57] „Atmospheric Air Plasma Surface Modification of Polyethylene Powder“ deals with a different plasma technology. Please explain this inconsistency. What the method was actually used for plasma treatment of polyethylene?
2. What was the standard of water absorption? What samples were used? You describe the square specimen as having 2 mm side length and 2 mm thickness.
3. From Figure 5.9 on page 46, a higher viscosity drop is seen at 160 °C by adding 5% plasma modified polyethylene compared to 5% untreated polyethylene. Why a higher viscosity decrease has appeared with plasma modified polyethylene than with untreated polyethylene?
4. Has the chemical treatment of coir fibres changed their diameter or their mechanical properties?
5. Did you considered application of composite with plasma modified polyethylene matrix and plasma treated fibre? Physical treatment compared to chemical treatment is more environmentally friendly. Would be possible to modify simultaneously polyethylene powder and coir fibres in one step? If not, what method would you propose for plasma fibre treatment?

Formal inaccuracies:

1. p. 4 – missing figure description
2. p. 5, 6, 13 – non-uniform marking of references for figures (Figure × figure × Fig.)
3. p.7 – different format of literature references (superscript instead of [])
4. in literature references, before [ a space should be written
5. p. 8 - links to Figure 2.3 are missing in the text
6. p. 20 – there are no table references in the text (Tab. 2.2 and Tab. 2.3)
7. p. 33, 48 – reference to wrong figure and table number

8. p. 32, 67 – Figure 4.3 and Figure 6.10 have low resolution
9. p. 42, 43 – unreadable marking of figures (A, B, C, D, E, F)
10. p. 56 - Table 5.2 – what mean “Mod @ 300%”
11. p. 58 – “two rol mil” – absent “l” (correct is mill)
12. p. 79 – Figure 7.11 – the last column should be labelled as PPE T instead of PPE UT.

The above comments and questions do not doubt the quality of the work. As summarized, the candidate for PhD degree has performed large amount of research, obtained new original results in the field of application of plasma modified polyethylene in composites with natural materials and fulfilled the stated goals of the thesis. The quality of the dissertation has been proved by the publication of two articles in the renowned impact journals.
In my opinion, the reviewed thesis fulfils all the requirements aimed for obtaining PhD degree.

**I recommend** this thesis to be defended orally, in front of respective committee.

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