Reviewer's Report on PhD Dissertation Thesis

"The application of plasma treated polyethylene and glass fibers in composites and sandwiches prepare via rotational moldings"

Author: **Zoya Ghanem**
Czech Technical University in Prague,
Faculty of Mechanical Engineering
Institute of Materials Engineering

The topic of the thesis is up to date and a very beneficial for industrial use. Polymer composites reinforced with fibers are intensively studied during the last years worldwide, and plasma treatment of polyethylene powder could be a new prospect to better adhesion to other material.

The dissertation deals with the applications of plasma treated polyethylene powder in combination with plasma treated glass fibers in composites and sandwich structures prepared via rotational molding. The work is well arranged. It consists of an Introduction, a Theoretical background, Thesis goals, Materials and experiments, Results and discussion as well as Conclusions. At the end of the work, there are all the obligatory parts as References and List of author publications. The theoretical principles as well as the research part were validated with 106 valuable references.

In the first chapter "Theoretical background" the author describes the technology of rotational molding, problematic of foam core sandwiches, composites materials, interface and adhesion and plasma treatment for adhesion improvement. Special attention is given to the latest trends and research results supported by the recent literature. In the next part, the four goals of the dissertation were set:

To optimize the rotational molding process of plasma treated/untreated polyethylene powder, To determine the effect of using plasma treated polyethylene on the adhesion between the polyethylene and polyurethane foam in sandwiches structures, To determine the effect of plasma treatment of polyethylene powder and glass fibers on the adhesion and on the mechanical properties of composites prepared via rotational molding. Last goal was very ambitioned, to demonstrate the possibility of the application of the developed materials in the selected industrial applications. The chapter „Materials and experiments" describes used materials and methods and conception of experiments. However, for

the huge number of planned experiments, their arrangement is a bit confusing. For greater clarity, would be better to use a diagram of the concept of the experiment rather than only description in the text. The methods used were well chosen and applied correctly in the practical part of the dissertation.

I highly appreciate the large range of the results achieved, which are treated in detail in part of "Results and discussion". The PhD candidate demonstrated the ability to work with the most modern measurement techniques and she correctly characterized the raw materials without treatment and after plasma treatment using SEM, optical microscopy, differential scanning calorimetry (DSC), FTIR etc.

The results of the experiments show a positive effect of plasma treatment of polyethylene powder it caused increasing the adhesion between polyethylene plates and polyurethane foam in sandwiches prepared via rotational molding. With using only 15% of plasma treated PE powder (1 min) in the mixture de-bonding force to polyurethane foam increased almost by 279 % comparing with samples prepared using untreated powder. Also composites prepared using plasma-treated powder and glass fibers showed better adhesion between the matrix and the fibers in comparison to composite without treatment of raw materials. Through her experiments, the PhD candidate proved the suitability of plasma treatment of raw materials for the rotomolding process.

The last ambitious goal was also successfully achieved during preparing a kayak from plasma treated polyethylene with 10% of glass fiber in Rock and roll rotational molding machine. The proposed solution lead to decrease the weight of the kayak from 21 kg of the original kayak to 17.4 kg of kayak made from the composites.

I mostly appreciate the already implemented application at the industrial level by Olivo Cold Logistics – polyethylene and polyurethane sandwiches based on plasma treated PE powder usable for producing insulated containers for food distribution

The results of Ph.D. candidate bring not only new theoretical knowledge in the field of plasma treated materials and polyethylene composites, but also practical experiences for rotomolding technology and already realised industrial application.

ORLEN UniCRE, a.s.

Revoluční 1521/84, Ústí nad Labem, PSČ 400 01
IČ: 62243136, DIČ: CZ62243136
e-mail: unicre@unicre.cz, www.unicre.cz

Registr. v OR KS v Ústí n. L., odd. B, vl. 664
č. účtu: 7009 411/0100, KB Ústí n. L.

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. How could the sizing of glass fibers affect the results of the PE - glass fiber composite? How the plasma treatment could interact with this sizing? What happens with sizing at the temperatures by rotomolding?
2. How do you imagine of recycling the composites you study?

Formal inaccuracies: There are very few formal inaccuracies in the text, such as in the description of the x-axis in fig 42 “pwoder” instead of powder or in chapter 5 polyethene instead of polyethylene.

ORLEN UniCRE, a.s.

Revoluční 1521/84, Ústí nad Labem, PSČ 400 01
IČ: 62243136, DIČ: CZ62243136
e-mail: unicre@unicre.cz, www.unicre.cz

Registr. v OR KS v Ústí n. L., odd. B, vl. 664
č. účtu: 7009 411/0100, KB Ústí n. L.

The above comments and questions do not doubt the quality of the work. Summarized, the candidate for PhD degree has performed large amount of research, obtained new original results in the field improving the adhesion between the polyethylene and the polyurethane foam in sandwiches prepared via rotational molding and in the field of application of plasma modified polyethylene powder in composites with glass fibers and fulfilled the stated goals of the thesis. The quality of the dissertation she has been proved by the publication of four articles in the renowned impact journals and two presentation on international conferences.

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.

Ústí nad Labem 17. 10. 2022

doc. Ing. Pavlína Hájková, Ph.D.
ORLEN UniCRE, a.s.
Revoluční 84
400 01 Ústí nad Labem
Czech Republic
Mob: +420 608 412 010
e-mail: pavlina.hajkova@orlenunicre.cz