

The external examiner report on doctoral thesis submitted at the Tomas Bata University in Zlin
by Ing. Martin Cvek

in fulfillment for the degree of Doctor philosophiae

entitled

Magnetorheological systems with optimized performance

This thesis prepared by Ing. M. Cvek covers the work on development of magnetorheological systems with controlled performance and enhanced stability properties through the particle grafting approach. The developed systems result in formation of a polymer shell, synthesized by atom transfer radical polymerization, capable of protecting the magnetic particles from thermo-oxidation and chemical stability. These particles have been tested in both magnetorheological suspensions as well as magnetorheological elastomers, exhibiting the magnetorheological effect, i.e. developing highly-organized internal structures upon exposure to external magnetic field. This effect has been currently utilized in numerous applications based on this external stimulus for a controlled change of rheological behavior of liquids or polymer matrices. Nevertheless, some drawbacks continue to exist. This thesis ambition is to provide the contribution to a particular problem that is a controlled coating of magnetic particles while maintaining a required magnetorheological behavior.

I am pleased to conclude already at this part of the review that this ambition has been achieved.

The thesis consists of about 50 pages Summary, referring to 160 references mainly from the last ten years, and is based on 4 publications printed in highly ranked journals and one submitted publication; in all of these publications Ing. Cvek is the first author and in two of them he is the corresponding author. The Summary is having an expected structure and provides brief but comprehensive information on the topic of magnetorheological systems, drawbacks of current systems and directions towards their improvement. It also contains the highlights for all the five publications, which are attached to this thesis. The text is smooth, written in a highly logical and clear way and, overall, represent a high quality scientific information. All this underlines the quality of Ing. Cvek, his level of knowledge from the respective subjects covered within this thesis to the ability to properly conveying this information to the reader.

As Ing. Cvek concludes, developed core-shell structures may contribute to the next generation of the magnetorheological systems that can be tailored towards specific applications using conventional systems. Apart from this aspect, I also highly value the scientific level forming the basis for this conclusion.

The following questions may be discussed during the thesis defense:

1. Already the abstract states that developed core-shell systems are more advantageous than conventional systems, already used in practical applications. Has such comparison been made, i.e. using a conventional system as a control next to the newly developed magnetorheological systems?
2. The second general question relates to the sentence in Motivation. I fully agree that “ tailoring of the properties is of particular interest, which helps to design a material towards a specific application...” Could the design properties vs specific applications be exemplified? Was such an approach, to achieve properties for a specific application, used in the thesis (note also the sentence on page 40 top “...to develop considerable τ sufficient for practical applications”)?
3. On page 20, the problem of recycling in case of magnetorheological elastomer systems is highlighted. Has the thesis contributed also to this aspect?
4. Part. 1.5, page 22: The drawbacks are well explained. Nevertheless, since these systems have been employed in numerous current applications, are these problems really so serious (thinking of the lifetime of brakes, clutches, etc)? Can the examples be given where the lifetime is limited due to listed drawbacks? Is it realistic to expect that ATRP-made shells will be economically feasible to replace the current conventional systems?
5. Page 35: what determined the “desired shell thickness”. Additionally, is it reasonable to expect that the molecular weight of the particle-grafted polymer equals to that formed using the sacrificial initiator (presumably) in the solution polymerization? Does the layer thickness correspond to the molecular weight of polymer (Table 1)? What are the critical parameters for a controlled coating of magnetic particles by polymers? Is the particle size also a critical parameter?
6. Page 38: The layers protect the iron particles from being oxidized. What is the mechanism for this protection.

In addition to publications included in this thesis, Ing. Cvek is the coauthor of additional 8 publications, 20 conference publications, participated on numerous projects and gained further experience during stays in foreign institutions, all in areas related to the magnetorheological systems.

In summary, the submitted thesis of Ing. M. Cvek meets the high standard quality of PhD thesis. I am pleased to recommend, without reservation, this thesis for public defense in a disputation and, after that, to award to Ing. M. Cvek the degree Doctor philosophiae.

Igor Lacík, DSc



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