

Opponent's Assessment of the Dissertation

Workplace: **Centre of Polymer Systems, TBU in Zlín**

Academic year: **2023/2024**

Student: **Anju, M.Sc.**

Doctoral degree program: **Nanotechnology and Advanced Materials**

Study course: **Nanotechnology and Advanced Materials**

Supervisor: **M.Sc. Raghvendra Singh Yadav, Ph.D.**

Reviewer: **prof. Ing. Marián Lehocký, Ph.D.**

Doctoral thesis title: Preparation and characterization of advanced spinel ferrite nanocomposites for electromagnetic application

Introduction:

The submitted work by Anju deals with the preparation and characterization of spinel ferrite nanocomposites.

In this thesis, various spinel ferrite nanoparticles were synthesized using sonochemical approach. Further, the synthesized spinel ferrite nanoparticles were incorporated along with the conducting filler such as commercially available graphite or synthesized reduced graphene oxide in thermoplastic polyurethane polymer matrix. This work was focussed on the development of the various polymer nanocomposite systems (a) Zn^{2+} substituted cobalt ferrite nanoparticles along with reduced graphene oxide in TPU matrix (b) Cu^{2+} substituted cobalt ferrite nanoparticles with reduced graphene oxide in TPU matrix (c) optimization of wt% of the conducting graphite and magnetic cobalt ferrite nanoparticles in TPU matrix. Therefore, the topic of the thesis can be considered highly relevant and, for many reasons, socially beneficial.

Achievement of Stated Objectives:

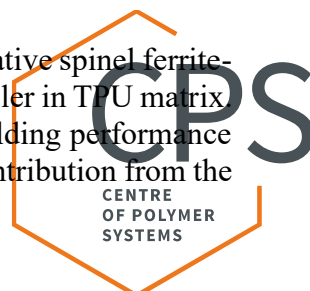
The thesis aims to investigate the structural, morphological, and electromagnetic properties of advanced polymer nanocomposites consisting of spinel ferrite nanoparticles and graphite or reduced graphene oxide for electromagnetic interference (EMI) shielding application.

Problem-solving Approach and Dissertation Results:

The problem-solving process occurred in several logical steps that sequentially built upon each other.

1. Synthesis of various spinel ferrite nanoparticles.
2. Synthesis of electrically conductive filler reduced graphene oxide.
3. Developing polymer nanocomposites.
4. Investigating the scattering parameters.
5. Investigation of the relation among complex permittivity, complex permeability, electrical conductivity, dielectric loss, magnetic loss, eddy current loss, skin-depth, attenuation constant and impedance matching coefficient, with EMI shielding effectiveness of developed nanocomposites.

The goals were successfully accomplished by the preparation of novel innovative spinel ferrite-based polymer nanocomposites along with rGO or graphite as a secondary filler in TPU matrix. All the developed polymer nanocomposites demonstrated superior EM shielding performance and were able to effectively attenuate the EM waves along with the major contribution from the



absorption of EM waves and therefore reducing secondary reflections. All of the developed polymer nanocomposites displayed value of $SE_T > 20$ dB and therefore making them as a suitable candidate for commercial applications.

Significance for Practice or Field Development:

The presented data contribute to a fundamental understanding in the field of applications for the prepared nanocomposites. The developed polymer nanocomposites are flexible, thin, and lightweight making it convenient for applications in X-band frequency range which includes application in aircraft, satellite, telecommunications, and in the field of radar stealth.

Formal Presentation and Language Quality:

The text is written with high expertise, addressing current issues and limitations in the field. It is well-structured, easy to read, and effectively uses technical terminology. The citation of 189 original literary sources, particularly recent literature, demonstrates thorough research. The formal presentation, including graphical elements, is of high quality. The language level is also commendable.

Overall Evaluation:

The dissertation is very well prepared, meeting all requirements. Minor issues do not diminish the overall quality of the work. Anju's capabilities are evident, and she has demonstrated maturity and proficiency in her field.

Suggestions:

I have no significant comments regarding the work, except for a few details that could be addressed differently. Firstly, there is an inconsistent format in the SEM images. For instance, the images in Figure 5.6 (page 53) include a visible size bar, whereas those on pages 54 and 55 contain an original description that is too small to read. I recommend consistently using size bars for all images. Additionally, abbreviations and symbols in the list should be sorted alphabetically.

Questions:

As part of the discussion, I would like to ask a few questions:

- Please explain why for some experiments TPU Elastollan C80A10 (chapters 4.1.3 and 4.2.3) was used while for another experiments TPU Elastollan 1195 A (chapter 4.3.2) was used?
- Please explain the main different parameters of these thermoplastic polyurethanes.

Conclusion:

In conclusion, I note that Anju, M.Sc. has demonstrated creative abilities in the given research area, and the thesis meets the standard requirements commonly set for dissertations in the respective field.

Therefore:

I recommend Anju's dissertation for defense and the conferment of the "doctor" (Ph.D.) academic title.

In Zlín, 26 Jun, 2024

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prof. Ing. Marián Lehocký, Ph.D.

