

FROM: Miroslav Raab, Professor of Macromolecular Technology

SUBJECT: Report on Doctoral Thesis

"Polymer Magnetic Composites for Microwave Absorbers"
or in Czech:

"Polymerní magnetické kompozity pro mikrovlnné absorbéry"

submitted by

Alexander V. Lopatin

to the

Tomas Bata University in Zlín

DATE: January 12, 2009

OPINION: Recommended

This is an interdisciplinary thesis combining two scientific fields, namely polymer materials science and radio engineering. It is aimed at exploring and development of next generation of microwave absorbers. (The author uses the abbreviations MWAs for microwave absorbers and EWAs for electromagnetic wave absorbers.) Correspondingly, the thesis integrates theoretical and practical aspects of the thesis topic. Obviously, Lopatin's study represents a continuation of the research of polymer composites with attractive electromagnetic properties that has been carried out in Zlín already for several recent years and is an important contribution to such long-term research efforts. The support from the supervisor and consultants is here obvious.

The thesis is divided into an introductory part (30 pages) and three original scientific papers, I, II, III (totaling 40 pages). Two of them (I, II) have already been published in a renowned scientific journal, the third paper (III) has been submitted for publication. Several co-authors of the papers indicate that these publications contain also material produced by someone other than the candidate. Nevertheless, Lopatin appears as the first author of all of the articles, which shows his substantial contribution to the theoretical background, experiments, structural and physical interpretation of the results

The well written and comprehensive introductory part provides the reader with a lot of information concerning health risk of electromagnetic field, classification, characterization and design of EWAs. This part would deserve a publication of itself. Unfortunately, radar frequency bands have not been included into the introductory part. (A list of radar frequencies is given as an appendix to this review.)

The thesis has a standard layout. It is presented in English and its style is very good, as far as I can judge it. On the other hand, the thesis contains many abbreviations, not common in the field of polymer technology (EWA, EMC, EMI, EMR, CI, FSS, MWA, RA, RAM, RF, SL, VNA). In some cases they are explained only once in the whole text. A reader would benefit from a list of their expanded forms.

The original papers (I, II, III) present theoretical background, experimental conditions and performance on newly developed radio absorbing systems. Two of the papers have passed peer review and have been published in a renowned international journal. This is a proof of their novelty and scientific level. In particular, these papers report on a developed layered absorber that outperforms comparable commercially available materials. I recommend the candidate to explain during the defense his contribution to this development and describe briefly but clearly the specific structure and function of this new generation of radio absorbers.

In sum, the thesis represents an important original contribution to the development of an interesting class of polymeric materials. The obtained original results, newly prepared materials and developed laboratory techniques will surely be useful for the future research at the Faculty of Technology of the Tomas Bata University in Zlin. Moreover, the thesis initiated a fruitful international cooperation.

I have some questions to the candidate that can initiate discussion during and after the defense.

- (1) There are generally three different strategies for the protection of organisms and devices from electromagnetic waves: reflection, shielding and absorption. Can you briefly compare these approaches?
- (2) Based on the appendix to this review, can you propose efficient absorbers for the individual radar frequency intervals?
- (3) Can you briefly discuss the possibilities of frequency tuning of microwave absorbers?
- (4) Suggest some realistic applications of the absorbers developed within the thesis..

These questions do not deny the good standard of the presented thesis. The candidate, Alexander V. Lopatin, has proven an expertise both in polymer materials science and radio engineering, originality and independence in his scientific work. The amount of his theoretical and experimental work for the thesis is quite substantial. I recommend the thesis for the award of PhD. degree by Tomas Bata University in Zlín.

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Appendix

Radar Frequency Bands

Band Designation	Frequency Range	Typical Usage
VHF 50-330 MHz.	Very long-range	surveillance
UHF 300-1,000 MHz.	Very long-range	surveillance
L 1-2 GHz.	Long-range	surveillance, enroute traffic control
S 2-4 GHz.	Moderate-range	surveillance, terminal traffic control,
C 4-8 GHz.	Long-range tracking,	airborne weather
X 8-12 GHz.	Short-range tracking,	missile guidance, marine radar,
K _v 12-18 GHz.	High resolution	satellite altimetry
K _a 18-27 GHz.		little used (H ₂ O absorption)
K _a 27-40 GHz.	Very high resolution	airport surveillance
mm 40-100+ GHz.		experimental

Source: AIAA (American Institute of Aeronautics and Astronautics)