Review of the Habilitation Thesis

Candidate:	**Lucjan KOZIELSKI** , Dr.inž.
Habilitation Thesis title:	**Physical Properties of Materials for Multifunctional Piezoelectric Transformer**
Home University:	University of Silesia, Faculty of Computer Science and Material Science, Technology and Mechatronics Institute, ul. Žitnia 12, 41 200 Sosnowiec, Poland
Host University:	Technical University of Liberec, Faculty of Science, Humanities and Education, Studentská 2, 461 17 Liberec 1.
Field of habilitation:	Applied Sciences in Engineering
Reviewer:	Jaroslav Nosek, prof. Ing., CSc.
Reviewer´s workplace:	Technical University of Liberec, Faculty of Mechatronics, Informatics and Interdisciplinary Studies, Institute of Mechatronics and Computer Engineering, Studentská 2, 461 17 Liberec 1.

Relevance and scientific importance of the Habilitation Thesis

Comment

The Habiliation Thesis „**Physical Properties of Materials for Multifunctional Piezoelectric Transformer**"of Mr. Lucjan Kozielski provides a complete description of the theoretical principles, technology and experimental results during the development of the multifuntional piezoelectric transformers. The author´s contribution to a novel piezoelectric transformer implementations, such as magnetic field and light-affected phenomena in piezoelectric transformers, is remarcable.
The achieved results demonstrate the scientific importance of the Habilitation Thesis.

Excellent		Higher than average	X	Average		Lower than average		Weak	

Fulfillment of objectives of the Habilitation Thesis

Comment

The objectives of the Habilitation Thesis are explicitly expressed in the Introduction (pp.9-10) and in the chapter 1.8 Main goal of this thesis: Detector implementation of piezoelectric transformer (pp.47-48).
The main author´s results are presented in the chapter 5. Piezoelectric transformer as a light intensity transducer, in the chapter 5.2 Piezoelectric transformer as a magnetic field detector from single phase multiferroics (pp.98-108), including 5.1 PLZT samples preparation (pp.984-98), and in the chapter 5.3 Piezoelectric transformer as a magnetic field harwester (pp.109-113).
These issues are discussed both theoretically and experimentally. The author reports the important contribution to the smart materials, especially to the technology of the Lead tanthanum zirconate ceramics (PLZT).
The results document the considerable experience of the author. The objectives have been fulfilled.

Excellent		Higher than average	X	Average		Lower than average		Weak	

Methods and approaches

Comment

The family of the modern piezoelectric ceramics and their applications has been studied by many author's for many years (see 199 references). The author focused to the attractive area of magnetoelectric multiferroics and optically active piezoelectric materials. He developed especially technology of special ceramics, desing of piezoelectrics transformers and their applications in multifunctional piezoelectric transformers.

Excellent		Higher than average	X	Average		Lower than average		Weak	

Research results and outputs

Comment

Based on the good knowledge of material science theory, the author presents the development of the multifunctional piezoelectric transformers. The results were published by the candidate mainly in impact-and reviewed journals (Japanese Journal of Applied Physics., only one author in [172], for example). In this Habilitation Thesis, the candidate cites own 8 papers, on which in 8 cases he is on the first place between co-authors. The author has the ability to work in an international team.

Excellent		Higher than average	X	Average		Lower than average		Weak	

Original contribution to the development of the discipline or practice

Comment

This work brings valuable theoretical and experimental results. The author also developed experimental methods for verification of properties of new doped multifunctional materials in nanoscale, using the high-resolution scanning electron microscopy, electron diffraction and X-ray photoelectron spectroscopy. The results were applied especially to the technology, optimization of the properties, and to the design of new family of multifuntional piezoelectric transformers with energy conversion. The theoretical and practical experience is important for effective results in practice.

Excellent		Higher than average	X	Average		Lower than average		Weak	

Formal presentation and language quality

Comment

This Habiliation Thesis is characterized by diligence in processing of chapters, and by their clarity and good graphic design. I appreciate the large number of references.
The author's language expression seems be very good.

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Excellent	x	Higher than average	X	Average		Lower than average		Weak	

Remarks /questions

Remarks:

Symbols in the List of symbols should be sorted alphabetically (Latin, Greek).

List of symbols containts some small inaccuracies. Some symbols used in the work are missing.

s_{ijkl} denotes components of the elastic compliance tensor, (in the symbol s^E_{ijkl}, the superscipt E denotes constant electric field, superscript D denotes constant electric displacement),

c_{ijkl} denotes components of the eleastic stiffness tensor, (in the symbol c^E_{ijkl}, the superscipt E denotes constant electric field, superscipt D denotes constant electric displacement), (p.33),

d_{ijk} denotes components of the piezoelectric-strain tensor,

g_{31} piezoelectric stres-tensor component (piezoelectric voltage constatnt),

T_{ij} stress-tensor components,

S_{kl} infinitesimal strain-tensor componets,

E vector of electric field intensity,

D electric-displacement vector, (the same symbol D author uses for diameter),

F vector of force,

t is used for proces time and for thickness of a capacitor, too,

u_i displacement along the X_i axis.

Questions:

1. Some symbols on the page 34 are not mentioned. Could candidate explain the symbols in Eq. (15) and (17)?
2. How to change the equation of motion (15), when body forces act on the piezoelectric body?
3. It is known that the linear theory is based on the assumption that the elastic deformations are very small, and that the piezoelectric body must not be subjected to any elastic prestressing or influence of the strong external electric field. How to change the electro-elastic equations, if these conditons are not fulfilled?
4. It is true to say that the experiment does not confirm the validity of the piezoelectric linear equations?

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Final evaluation of the Habilitation Thesis

The Habilitation Thesis of Mr. Lucjan Kozielski is well written, delivers a nice overview on the research area, and contains new theoretical and practical results.

The work is remarkable not only for its focus on modern piezoceramic materials, their preparation and optimization of their material properties, but also on experimental verification and use in design of new multifunctional piezoelectric transformers.

The candidate completed his Habilitation Thesis in 2016, and the reviewer got it in April 2017.

The presented results can be characterized as very good.

The author is capable of both theoretical and practical work for scientific research combining recent material science theory and extending them to a new level of application of the multifunctional piezoelectric transformers with changes in energy induced by light and magnetic field.

So overall, I recommend the acceptance of the Habilitation Thesis of Mr. Lucjan Kozielski for the defense before the Scientific Council.

After successful defense, I recommend the granting the title "Docent".	Yes	

Liberec, April 10, 2017

Signature of the opponent

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