

Review of the PhD thesis DIELECTRIC PROPERTIES OF THIN TANTALUM AND NIOBIUM OXIDE LAYERS by Mrs Inas Abuetwirat

PhD Dissertation Thesis Review

Dielectric properties of thin tantalum and niobium oxide layers

presented by

Mrs Ing. Inas Faisal Abuetwirat

Department of Physics,
Faculty of Electrical Engineering and Communication,
Brno University of Technology,
Brno,
Czech Republic

The PhD dissertation thesis “Dielectric properties of thin tantalum and niobium oxide layers” deals with thin Ta and Nb oxide layers, which are essential functional components in Ta and Nb electrolytic capacitors. The thesis is so much more interesting, because the mechanisms of operation of both Ta and Nb systems are described in detail, which testifies to the wealth of information and findings which the PhD candidate amassed.

The objectives of the thesis are stated as 1) studies of the dielectric relaxation of thin film material Ta₂O₅ and Nb₂O₅ at electrolytic capacitor Ta/Ta₂O₅/MnO₂, NbO/Nb₂O₅/MnO₂, respectively, using a low frequency dielectric spectroscopy over the large temperature and frequency range 187 K – 385 K, 1 Hz – 10 MHz, and 2) to ascertain the impact of the thickness of the oxide layer on dielectric relaxation and conductivity.

The thesis is divided into five major parts: Material under study, Theoretical foundations, Experimental methods, Measurements and Results and analysis. The thesis also contains Objectives of the present work and Conclusions and other additional chapters like Introduction, Background, Literature, Publications and Curriculum vitae. The PhD thesis is 104 pages long.

Parts Material under study and Theoretical foundations are quite extensive and they testify to the depth of study of the PhD candidate. The part Theoretical foundations itself is 40 pages long (pages 20 – 59) and consists of three chapters (3.1 Dielectric relaxation spectroscopy, 3.2 Conduction mechanism and 3.3 Electrolytic capacitors. These three chapters provide an overview of the current finding on dielectric relaxation, conductivity of thin films and properties of electrolytic capacitors. These chapters prove that the PhD candidate is able to master a large volume of scientific information and to explain these topics to readers in a coherent and structured manner.

The focus of the dissertation thesis is part 7, Results and analysis, which represent original results achieved in the experimental work of the PhD candidate, together with their interpretation. Here the PhD candidate presents her own measurements on Nb and Ta capacitor made at different temperatures, frequencies and thicknesses of oxide layers. The text

is full of figures showing the results. The analysis includes the description of the relaxation behavior by the Havriliak – Negami equation along with temperature dependence of HN parameters. That is an original contribution that has not been applied to electrolytic capacitors elsewhere.

The list of references contains 44 items and so it proves the width of the studies of Mrs. Inas Abuetwirat related to her work.

Formally, the thesis submitted is of a very high quality, figures and tables are drawn clearly and in an easy-to-understand way. My impression is very good; the whole work was done quite carefully.

The thesis presents a well balanced composition of theoretical knowledge and experimental work with conclusions summarized on pages 97 – 98.

My comments are as follows:

What are Bode plot and Nyquist plot (page 29)?

Why is in Chapter 3.1 the subchapter 3.1.11 on Hamon approximation? Is Hamon approximation related to experimental methods used in this dissertation thesis? How?

Page 70, top paragraph: You say that you did your measurements on Ta capacitors in the frequency range 1 Hz to 10^7 MHz. Your figures show, however, that you did the measurements up to 10 MHz, i.e. 10^7 Hz. This is probably a misprint.

You bring a wealth of new information. However, the plots of α , β , and $\Delta\epsilon$ would deserve a more extensive discussion. Could you explain the meaning of these parameters and, in particular, what we can learn from their temperature dependences, e.g. in Figs. 7.5., 7.6. and 7.19?

I would like to stress that my comments do not affect my overall positive assessment.

Conclusion:

The Ph.D. candidate, Mrs. Inas Faisal Abuetwirat proved her knowledge and experience in a range of methods used for the study of polymers as well as her ability to apply these methods for the evaluation of PEO/PVA blends with oxide nanofillers. Therefore I recommend her PhD dissertation thesis to be

ACCEPTED

for the final talk before the Board of Examiners. After successful discussion, I recommend that Mrs. Inas Faisal Abuetwirat be

AWARDED THE DEGREE OF THE DOCTOR OF PHILOSOPHY (Ph.D.)

In Brno, 7th December 2014

Zdeněk Chobola
M.Sc., PhD, Professor
Department of Physics
Faculty of Civil Engineering
Brno University of Technology
616 00 Brno
Czech Republic