IEEE Conference on Electrical Insulation and Dielectric Phenomena (CEIDP)

Cancun, Mexico, October 21-24, 2018

Tutorial: Optimization and Sensitivity Analysis

October 21, 2018 F. Baudoin, F. Bugarin, and S. Segonds

Description

Various physical models have been implemented to describe the mechanisms of charge generation and transport in solid dielectrics. These models require the handling of a number of parameters like injection barrier, mobility, trapping coefficient, etc. Most of these parameters cannot be determined by independent experiments and it is a heavy task to estimate parameter values that best fit experimental data. This tutorial aims at systematizing this part of the modelling activity through the use of optimization and sensitivity tools in order to help researchers:

- model the optimization problem;
- identify ready-to-use solutions for minimization, or at least find some ways to build such solutions using state-of-the-art tools;
- understand the role played by the sensitivity on the minimization process.

In our case and for this tutorial, the physical model will be a bipolar charge transport model without source term described as following:

$$j(x,t) = \mu.E(x,t).e.n_{\mu}(x,t) \qquad (1)$$

$$\frac{\partial n_x(x,t)}{\partial t} + \frac{1}{e}\frac{\partial j(x,t)}{\partial x} = 0 \qquad (2)$$

$$\frac{\partial E(x,t)}{\partial x} = \frac{e.n(x,t)}{\varepsilon} \qquad (3)$$

where j is the transport current of mobile carriers, μ the mobility, e the charge of carriers, E the electric field and n the net carrier density.

We suppose that charge generation results from injection at the electrodes according to a corrected Schottky law (there is no injection when the electric field at the electrode is null):

$$j_{inj} = AT^2 \exp\left(-\frac{ew}{k_B T}\right)\left[\exp\left(\frac{e}{k_B T}\sqrt{\frac{eE_{electrode}}{4\pi\varepsilon}}\right) - 1\right] \qquad (4)$$

where j_{inj} is the flux of charges at the electrode, k_B is the Boltzmann's constant, $A = 1.2\text{x}10^6\ \text{A.m}^{-2}.\text{K}^{-2}$ is the Richardson's constant and w is the injection barrier.

Schedule

9.00	Welcome by the Chair, Fulbert Baudoin
9.15	Lecture: Basics of optimization parameters
10.15	Coffee break
10.30	Applications to basic transport charge models
12.00	Lunch break (on own)
13.30	Lecture: Basics of sensitivity
2.30	Applications to basic transport charge models
3.15	Coffee break
3.30	Applications to basic transport charge model
5.00	Adjourn

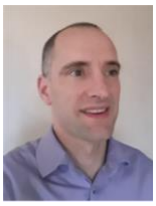
Registration

- This tutorial is limited to 20 students in order to provide a quality learning experience;
- Each registrant must bring their own laptop with software already installed (Software will be provided free of charge to all registrants);
- Payment ($75) is required at time of registration.

Biographies of the Tutors

Fulbert Baudoin *is chair of the technical committee of* DEIS / IEEE: *Numerical Methods Applied to Dielectrics. He is currently Associate Professor at the LAPLACE Laboratory in Toulouse, France. His research interests lie in the area of modeling of charge transport in polymeric materials.*

Florian Bugarin *is currently Associate Professor at the ICA Laboratory in Toulouse, France. His research interests lie in the area of numerical optimization in experimental mechanic and computer vision applications.*



Stéphane Segonds *is currently Associate Professor at the ICA laboratory in Toulouse, France. His research interests lie in the area of sensitivity analysis and uncertainty quantification in mechanics***.**