Time Domain Simulation Of Insulating Dielectric Materials With Non Instantaneous Polarization

Tianbo ZHOU[1], Lionel LAUDEBAT[1], Marie-Laure LOCATELLI[1], Pierre BIDAN[1]

[1]Laboratoire LAPLACE, Toulouse, France

Abstract

This paper presents a solution to simulate the dielectric relaxation in insulating materials using COMSOL Multiphysics in time domain. Indeed, the polarization P in a dielectric material may be divided into two parts according to the response time, the electronic polarization and the dipolar polarization.These two can respectively be regarded as an time instantaneous polarization and a time-dependent polarization, resulting from the orientation of both different types of dipoles. In the "Electric Currents" module, COMSOL Multiphysics uses an equation where the polarization is only considered as an instantaneous mechanism. However in many cases, taking the time-dependent relaxation into account in time domain simulations is necessary. For example, dielectric relaxations modify the stress constraint's supported by an insulating material in electrical engineering or power electronics systems during transient phases. In the paper, a description of the physical mechanisms will be first presented. Then, the method proposed for their implementation in Comsol Multiphysics will be exposed, using the particular case of the relaxation Debye's model. The time domain parameters of the associated model will be identified from dielectric spectroscopy measurements. Examples of time domain simulation results will be given for basic geometrical configurations encountered in electrical engineering isolation systems (insulating structures with parallel plane or tip/plane electrodes) and under different excitation signals (DC, AC, step response, …).