PhD Position at LAPLACE – Laboratory on Plasma and Energy Conversion

Investigation of physical processes at polymer insulation/conductive filler contact

proposed by Laplace Laboratory, University of Toulouse, France, in collaboration with ABB Corporate Research, Baden, Switzerland.

Abstract The PhD work would be essentially of experimental nature, with the objective to settle appropriate methodologies for understanding the relation between electrode contact interface properties and the low-frequency electric conduction behavior of insulating polymers.

Outlines of the Research Topic. The development of HVDC technology faces the problem of material design and optimization in a context where phenomena at play in dielectrics under DC stress are far from being under control. Space charge effects in the bulk of dielectric materials are important issues encountered in this context. Charges may enter or accumulate at various types of interfaces (metal/dielectric, semiconducting screen/insulating materials, dielectric/dielectric) and make it difficult to estimate the electric field distribution both in transient and steady state conditions. The prediction of the field distribution is, however, the most important pre-requisite for designing insulation devices.

Progress in this field goes, e.g., with systematic materials characterization through space charge or conductivity measurements as examples. This is expected to provide quantities related to the behavior of bulk materials in design-oriented models for DC. However, for properly accounting for processes that play at insulator-electrode interfaces, boundary conditions have to be settled. Such boundary conditions encompass for example charge exchange at the metal-electrode contact. The objective of the thesis is to improve our current understanding of the electrical processes at the interface. This will be achieved 1) by characterizing at the macroscopic scale the effect of the conducting or semicon (= carbon black filled polymer) electrode on the behavior of the system constituted by material and electrodes, and 2) by implementing state-of-the-art near field microscopy techniques (atomic force microscopy (AFM), Kelvin probe force microscopy (KPFM)), in order to obtain information at the nanometer scale on charge exchange processes at the interfaces.

Context. The host team ('Solid Dielectrics and Reliability' from Laplace[1]) has 20 years experience in characterizing insulating materials by means of luminescence, current and luminescence techniques, with a strong experience on polyethylene materials used as electric insulation for cables. Among available equipment, an AFM microscope with electrostatic modules, aimed at providing information on charging phenomena at the nanometer scale. The PhD will be developed in close collaboration with scientists from the Corporate Research Center of ABB, a leading manufacturer in the field of AC and DC Electrical Engineering Systems and Components.

Keywords: polymeric materials, dielectric physics, charge injection, high voltage insulation, high voltage direct current (HVDC).

Place: LAPLACE Laboratory, Paul Sabatier University, Toulouse

Duration: 3 years, starting **Dec. 2014 / Jan.2015**

Salary: ≈2000€/1650€ rough/net per month

Expected profile: Candidate having a Master degree in Materials Science with knowledge on Dielectrics Physics; with inclination to experimental research. Good skills in English are required.

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Applicants are required to provide a CV and application letter.

[1] http://www.laplace.univ-tlse.fr/