

• General objectives

Understanding and modelling of transport, polarisation and ageing mechanisms in organic insulations – identification of leading processes in failure – study and characterization of new materials for application in components and systems of Electrical Engineering

• Keywords

Materials for Electrical Engineering – Solid insulations – Polymers – Conduction – Luminescence – Space charge – Ageing

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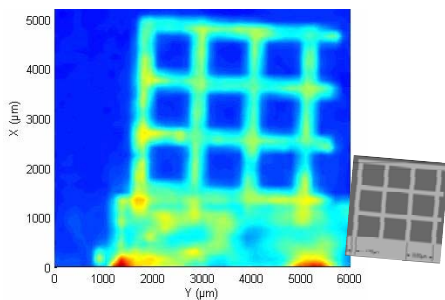
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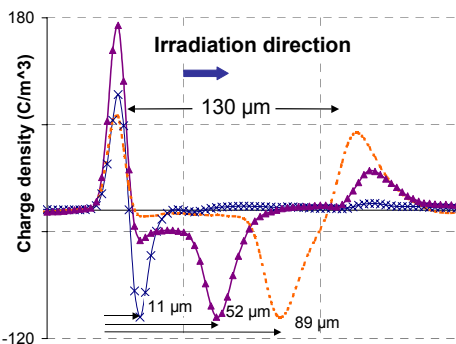
• Research topics

Space Charge Measurement

- ♦ Development and improvement of space charge measurement techniques
- ♦ Complementarities of PEAⁱ and FLIMMⁱⁱ techniques
- ♦ Coupling with other electrical measurements: electroluminescence, conduction



Polarisation profiles measurements by FLIMM in subsurface of piezoelectric films with tailored polarisation.



Profiles of internal charges obtained by PEA on FEP irradiated by an electron beam (30 to 110keV)

Current projects

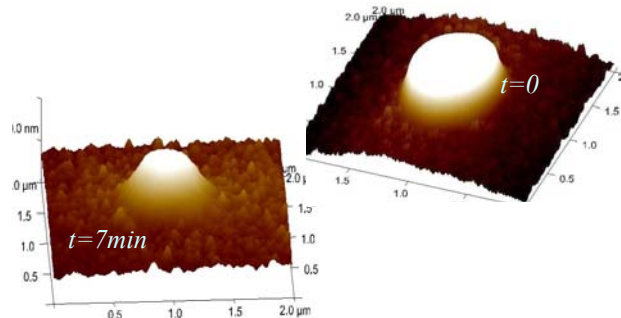
- ♦ Space charge measurement under alternating stress
- ♦ Cartography of charge density by FLIMM in contactless mode

Structure/Properties Relationships

- ♦ Application of various electrical and physico-chemical characterization techniques to infer charge generation, transport and trapping mechanisms in insulating materials
- ♦ Evaluation of new materials for potential application in electrical engineering systems and spacecrafts



Set-up for measurement of luminescence stimulated by various in-situ excitation sources: electrical field, UV, temperature, plasma.



Measurement of charge flow by AFM on a SiNx layer (coll. LAAS-Toulouse)

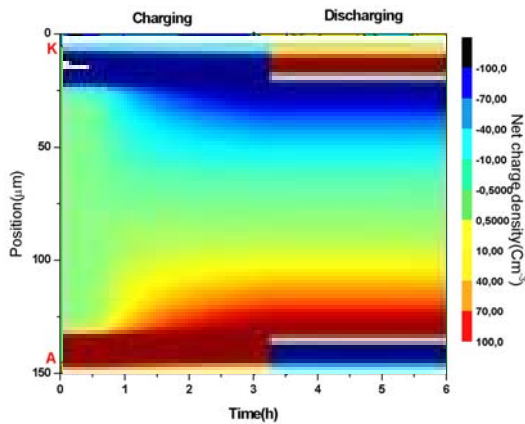
Current projects

- ♦ Formulation of cable material for application to high voltage DC energy transport
- ♦ Charging of dielectrics involved in micro-electro-mechanical systems

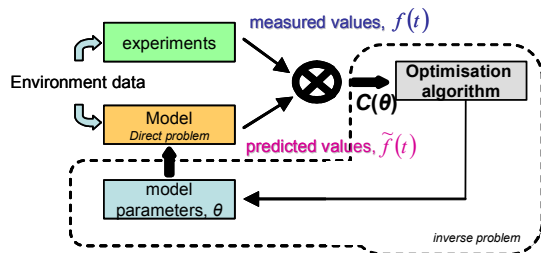
• **Research topics - continued**

Numerical Modelling of Transport

- ◆ Identification of mechanisms leading to the apparition and accumulation of electrical charges in solid dielectrics
- ◆ Resolution of bipolar models of transport with charge trapping and recombination accounting for the experimental behaviour in non-stationary state
- ◆ Development of optimization techniques
- ◆ Model validation through parallel approaches simulation/experiments



Simulation of charge accumulation in a polyethylene material under DC stress and subsequent discharging



Principle of optimization techniques. The aim is to identify the optimal parameter set θ

Current projects

- ◆ Description of charge injection processes in synthetic insulations
- ◆ Application of optimisation techniques to parameters determination in physical models

▪ **Collaborations -Partnership**

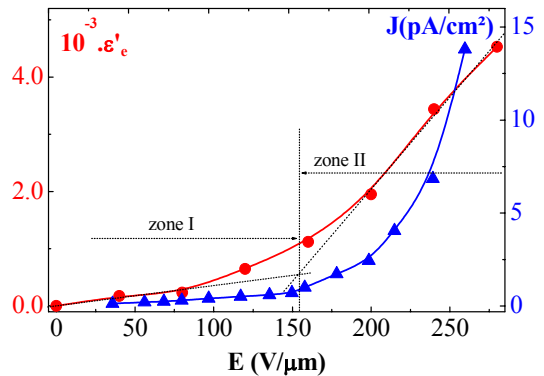
- ◆ Academic Collaborations: LIMAT U. Bologna (It), EEL U. Leicester (UK), ICTP/CSIC Madrid (Sp), FiveLab (Jp), Musashi Institute of Technology (Jp), Inst. Physik U. Potsdam (All), U. Sfax (Tun), G2ELab (Grenoble), Lab. de Mécanique des Solides (Poitiers), LAAS and CIRIMAT (Toulouse).
- ◆ Institutional Supports: Pôle de compétitivité AESE (NACOMAT), RTRA Science et Technologies de l'Aéronautique et de l'Espace (SYMAIE), GDR SEEDS, Région Midi-Pyrénées
- ◆ Industrial Partnership: SileCable, Schneider Electric, CNES, ONERA, Astrium

▪ **Application area**

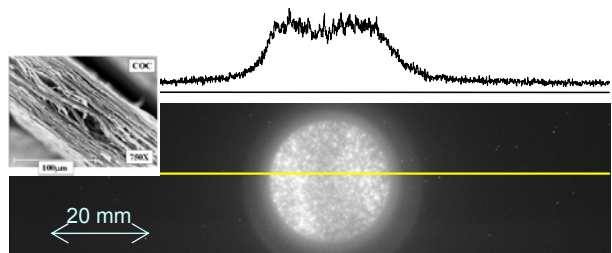
- ◆ Electrical Engineering systems: Cable insulations, Transformers
- ◆ Space Environment: ESD issues and Materials ageing
- ◆ Micro-Electro-Mechanical Systems

Ageing - Reliability

- ◆ Reliability is understood as the management of irreversible phenomena induced by electrical and environmental stresses
- ◆ Implementation of acoustic, optical, electrical... tools for revealing and unravelling irreversible evolutions of materials under stress
- ◆ Development of physical models of these evolutions with as aim to forecast the long term behaviour



Mechanical strain of a 25μm-thick PET film compared to the conduction characteristic



Electroluminescence in the plane of a cellular PP film (100μm, 1.3kVrms AC 50Hz)

Current projects

- ◆ Optical diagnosis of electrical ageing of epoxy resins under moderate electrical stress
- ◆ Build-up of an experimental tool for diagnosing electron beam induced processes in insulations

ⁱ Pulse Electro-Acoustic Method

ⁱⁱ Focused Laser Induced Modulation Method