Control of the charge transport in dielectrics by plasma processed nanostructured layers

K. Makasheva[1], C. Laurent[1], C. Villeneuve-Faure[1], C. Bonafos[2],
L. Milliere[1], A. Pugliara[1,2], L. Boudou[1], and G. Teyssedre[1]

[1]LAPLACE, Université de Toulouse; CNRS, UPS, INPT; 118 route de Narbonne, F-31062 Toulouse cedex 9, France
[2]CEMES-CNRS; Université de Toulouse, 29 rue Jeanne Marvig, BP 94347, F-31055 Toulouse cedex 4, France

Electrostatic charging of thin dielectric layers represents an intensive field of scientific research due to the numerous applications of dielectric materials in electrical engineering, yet requiring a comprehensive study of their behavior under electrical stress. The charge injection in dielectrics is at the origin of space charge formation which induces modification in the electric field distribution and leads to unexpected dielectric performance. Although the electrostatic charging of thin dielectric layers lays down the principle of operation of various technological devices, like non-volatile memories or electret based microphones, it is considered the main cause of electrostatic sticking in MicroElectroMechanical Systems (MEMS). Charge injection in polymeric materials under DC stress remains the major drawback for polyethylene-based insulation used in HVDC applications.

New dielectric engineering concept intending a net improvement of the performance of dielectric layers and an increase of their reliability will be presented. Instead of synthesis of new dielectric materials we have developed a new class of dielectric layers that gain their performance from design rather than from composition. The nanostructured dielectric layers were deposited in a plasma process and tested under electrical stress. The obtained results show that strong gradual variation of the conductive properties across the nanostructured dielectrics provides efficient charge transport in depth of the structure and reduces the electric field at the surface, decreasing in that way the density of injected charges. Owing to the versatility of the plasma processes the nanostructured dielectric layers offer a viable solution for space charge moderation in different HVDC applications. They also open the way of understanding electrostatic charging phenomenon in nanocomposite materials.