Université catholique de Louvain **UCL** SECTEUR DES SCIENCES ET TECHNOLOGIES

Institut de la Matière Condensée et des Nanosciences

Invitation à la soutenance publique de thèse

Pour l'obtention du grade de Docteur en Sciences de l'Ingénieur

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Ingénieur

Charge conduction and dissipation in fibers and felts: study by scanning probe microscopy

Electrification and electrostatic discharge (ESD) phenomena are known as serious risks in many applications, such as sophisticated microelectronic devices in electronics industry, in the chemical industry and in industries using filters. This thesis focuses on a deep understanding of the mechanisms at the microscopic scale of charge conduction and dissipation in antistatic felts and different kinds of fibers, such as polyester fiber and conductive stainless steel fiber. Various atomic force microscopy (AFM) electrical modes were used to study the surface electrical properties. The surface electrical conductivity/resistance was studied by current sensing AFM (CS-AFM) and 'ResiScope' module. Kelvin probe force microscopy (KPFM) was used to measure the surface contact potential.

In this scope, different experimental procedures and models were developed to facilitate the analyses and investigation of these mechanisms from three points of view: first, surface electrical characterization of stainless steel conductive fiber (Bekinox®) was performed for understanding the surface contact conduction mechanism. The contact (surface) resistance mainly presents a semi-conducting behavior with a dominating p-type character. This behavior is accounted for by the presence on the surface of the stainless steel fibers of a passivation layer mainly composed of chromium oxide. The tip-surface contact may be modeled as a metal-insulator-metal (MIM) junction and the I-V curves were fitted using the electron tunneling model; second, surface contact electrification experiments have been then firstly successfully performed on the insulating surface of polyester fiber in contact with a conductive fiber using biased KPFM tips. With positive tip bias, charge spots have been deposited in a reproducible manner. The density of deposited charges on the fiber surface was observed by KPFM as a function of time and relative humidity. Concerning the dissipation mechanisms, two main mechanisms were identified with different importance depending on the RH value; the third topic is then a systematic study of charge transfer and discharge processes between polyester and conductive fiber surfaces using KPFM. A single isolated insulating polyester fiber and an insulating polyester fiber with conductive Bekinox® fibers in galvanic contact were compared, in order to understand the influence of the presence of conducting fibers. The possible charge transfer and discharge mechanisms involved have been discussed.

In conclusion, the successful development of new experimental procedures and methods allowed a detailed and systematic study of different electrical mechanisms in fibers and felts. This thesis also gave insight into the possible explanations and models to various observations. AFM based electrical modes appear to be promising for the investigation of the various electrical mechanisms not only for flat surfaces but also for rough, cylindrical fiber surfaces.

Mercredi 7 décembre 2016 à 15h00

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