Ions or "Cryptoelectrons" in the Electrification of Diaelectric Materials

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As part of our program on the investigation of the early stages of crystal nucleation of polar crystals on the surfaces of charged dielectric materials, our group is investigating the induced freezing of super-cooled water on the surfaces of pyro-electric LiTaO3 [1, 2]. Recent reports in the literature [3-6] claimed that either dielectric polymers such Teflon rubbed by Poly-methyl methacrylate (PMMA), or PMMA itself are charged with electrons, defined "cryptoelectrons", at concentrations as high as $>10^{13}$-10^{14} electrons/cm^2, which are two orders of magnitude higher than the charge that can be sustained on the surfaces of pyroelectric materials in air. This theory of the existence of "cryptoelectrons" was deduced from suggested "redox" reactions of Pd^{+2}, Fe^{+3} to Fe^{+2}, Cu^{+2}, H^+ and others systems with even higher "redox" potentials.

We provide an alternative explanation of the role of the "cryptoelectrons", based on X-ray photoelectron spectroscopy (XPS) and vibrating probe (Kelvin probe)[7]. Our data show that the surface charge created on PMMA and Teflon rubbed with PMMA does not reduce Cu and Pd ions moreover it does nor exceed 10^{10} electrons/cm^2. Instead, rubbing Teflon with PMMA causes material exchange, probably accompanied with broken chemical bonds and formation of chemically polar active species (containing >C=O groups), and promotes adsorption of Cu^{2+} and Pd^{2+} ions from aqueous solutions on rubbed Teflon, which was misinterpreted as electrochemical reduction. On the base of these studies, we reject the hypothesis of charging dielectrics by "cryptoelectrons" and support the view that these surfaces are charged by uncompensated ions. Possible differences between these materials and charged pyroelectrics in the induced nucleation of ice will be discussed.

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