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SURFACE ELECTRICAL RESISTIVITY OF INSULATORS

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Surface electrical conductivity and charge transport in insulating materials, including strong insulating polymers is known to be very complex in mechanism [1,2]. Such electrical conductivity involves structure dependence, imperfections and impurities and also the problems associated with commonly used measuring techniques (e.g., difficulties in making good electrode contact and time delays due to the establishment of equilibrium charge displacement). The reproducibility of results has also been poor.

A method is presented here for measuring surface charge decay, and theory has been developed so as to produce determinations of resistivity in the surface region of insulator films or wafers [3]. This method incorporates the use of a coaxial cylindrical capacitor arrangement and an electrometer interfaced to a PC.

The charge transport theory given here is based on Mott-Gurney diffusion [4], and allows easy interpretation of the experimental data, especially for the initial phase of surface charge decay. Resistivity measurements are presented for glass, mica, perspex and polyethylene, covering a range of 10^9 to 10^{18} Ωm, as an illustration of the useful range of the instrument for static and antistatic materials, particularly in film or sheet form. Values for the surface charge diffusion constants of the materials are also presented.

The charge transport theory has also been extended to allow the experimental and computational theoretical comparison of surface charge decay not only over the initial phase of charge decay, but also over longer times. The theoretical predictions show excellent agreement with experiment using the values for the diffusion constants referred to above.

[1] D. A. Seanor "Electrical Properties of Polymers" Ch 17 in "Polymer Science" (North Holland Pub. Co. 1972).

[2] D. K. Das-Gupta, IEEE Trans. Electrical Insulation 27, 909, 1992.

[3] J. Liesegang, B. C. Senn and E. R. Smith "Resistivity of antistatic and static insulators from surface charge measurement" J. Appl. Phys. 77 1995 pp.5782-5785.

[4] N. F. Mott and R.W. Gurney "Electronic Processes in Ionic Crystals" (Oxford University Press, 1948).