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Talk Invited Invited Talk

STRETCHED EXPONENTIAL HUMIDITY DIFFUSION FOR NONLINEAR TRENDING

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In studying the relative humidity dependence of the transient current in polymer thin films, if one allows the humidity in the chamber to increase and samples the current through a thin film as a time series, the time dependence of the relative humidity in the chamber becomes significant, since any chaotic behavior in the transient current could, in principle, be attributed to chaotic behavior in the time dependence of relative humidity.

The stretched exponential function is an empirical function that describes relaxation rates of many physical properties of complex systems such as polymers and glasses, dielectric relaxation, discharge of capacitors. Such relaxation phenomena have also been observed in diffusion phenomena with noise. Hence, it can serve as a good model for the absorption of relative humidity into the PEG polymer sample. A simple exponential relaxation with the functional form given below fails to give a satisfactory fit and shows systematic departures both during the build up and saturation

$$RH = a_1(1 - a_2 \exp(-\frac{t}{t_0})) \tag{1}$$

A stretched exponential function of the form below, where the residual relative humidity in the chamber is modeled by the product of an absorption coefficient and the stretched exponential function, gave a very good fit with a residual chi square per degree of freedom of 0.134048.

$$RH = a_1(1 - a_2 \exp(-(\frac{t}{t_0})^\alpha) \tag{2}$$

The fitted parameter values are $a_1 = 90.3199 \pm 0.001973$, $a_2 = 0.640363 \pm 0.0001099$, $t_0 = 43933.27 \pm 2.393$, $\alpha = 0.661957 \pm 0.0001763$. Similar results have been obtained for the time dependence of the relative humidity for PAF and hydrogenated PEG samples, showing that the stretched exponential form has some degree of universality and the diffusion process of humidity into the polymer sample departs from Fick's Law. The value of the stretching exponent is compatible to that observed in the literature for short range forces.

This functional form can also enable repeating the detrended fluctuation analysis for the transient current using nonlinear detrending with the functional form given above and this is expected to eliminate systematic errors that can be hidden because of linear detrending.