Polyethylene Glycol is known to have an irregular current characteristic under constant voltage and slowly varying humidity. In this study the current through a Gamma-isocyanatopropyltriethoxysilane added Polyethylene glycol (PEG-Si) sample is analyzed for chaoticity. In previous studies it has been suggested that, after reaching a certain humidity level, a phase transition occurs from a semi crystalline state to a gel state, fluctuations in the elastic force relaxations and in the number of Hydrogen bonds cause sudden decreases and increases in the current successively. The irregular behavior of current through PEG-Si thin films as a function of increasing relative humidity is analyzed using nonlinear time series analysis and detrended fluctuation analysis. Low dimensional chaos with increasing maximal Lyapunov exponents with increasing relative humidity up to 72% is observed, after which the Lyapunov exponents settle to a constant value of 0.01. Such a behavior is consistent with the phase transition from the semicrystalline state to gel state. A detrended fluctuation analysis of the same data confirms the presence of three regions which probably corresponds to a pure crystalline state, a transition region as more water molecules are adsorbed and a final gel state.