Chaotic behavior in polymers

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Polymers are large and relatively complicated molecules that involve a multitude of bonds ranging from covalent to ionic as well as hydrogen and Van der Waals. Moreover, they may contain impurities and defects. It is only natural that such complicated structures will display instabilities and metastable states, which delay the attainment of a steady state for hours, days, and even years at times.

Instabilities cause many measurable properties of polymers to vary in an apparently random fashion over time. Despite of this irreproducibility, reproducible chaotic behavior is often seen under close scrutiny.

Our measurements of the time variation of the current through thin films of PMMA and PEG under high relative humidity conditions demonstrate a positive Lyapunov exponent and agree with a classical one-dimensional randomly pinned charge density wave model in the former, while they confirm a phase change from semi-crystalline to gel state for the latter. The phase change is further supported by the presence of two distinct regimes in a detrended fluctuation analysis of the time series of the PEG conductivity data.