Unwinding dynamics of polymers: a model for single biomolecules?

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The relaxation dynamics of a polymer wound around affixed obstacle constitutes a fundamental instance of polymer with twist and torque and it is of relevance also for DNA organisation and transcription of DNA into RNA. After an introduction on polymer physics and static properties of the winding of a polymer, we present our results on the unwinding dynamics by means of simulations and Langevin equation analysis. The latter predicts a relaxation time scaling as a power of the polymer length times a logarithmic correction related to the equilibrium fluctuations of the winding angle. The numerical data support this result and show that at short times the winding angle decreases as a power-law. This is also in agreement with the Langevin equation provided a winding-dependent friction is used, suggesting that such reduced description of the system captures the basic features of the problem. Moreover, we give a quantitative description of the existence of two regimes during the relaxation and a split of the polymer between two parts: a helical part and a random coil.
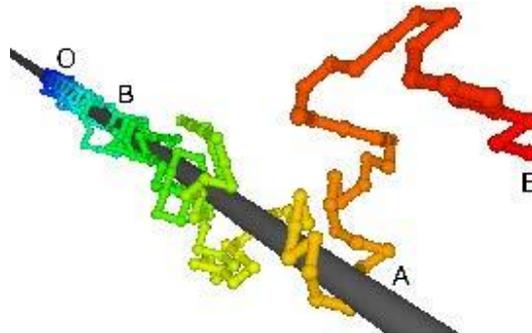

Figure 1: Unwinding process of a polymer: initially, the polymer if fully wound around a bar in a helical configuration with one end attached and the other end free. The relaxation proceeds through the rotation of the free end around the bar with an increasing coil. We give a quantitative description of this process: two regimes at short and large time, and in each of these regimes a split of the polymer between a helical part and a random coil. This model suggests possible applications for the description of biomolecules (namely DNA organisation and transcription).

[1]   *Unwinding relaxation dynamics of polymers,* J.-C. Walter, M. Baiesi, G. T. Barkema and E. Carlon, *Phys. Rev. Lett.* 110, 068301 (2013) cond-mat/1301.2777

[2]   *Unwinding dynamics of a helically wrapped polymer* in preparation Walter J-C, Baiesi M, Carlon E & Schiessel H (2014)