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Topological polymeric soft materials

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Materials built of topologically interlocked polymer rings have recently gained considerable interest in supramolecular chemistry, biology, and soft matter. Two typical exaples are polycatenanes, linear chains of concatenated rings, and the kinetoplast DNA (kDNA), the mitochondrial genome of trypanosomatids, formed by ~5000 dsDNA minirings linked together to form a 2D surface whose topology is on average conserved through replication. Here I present the results of several ongoing collaborative efforts, all highlighting the role of topological interactions in shaping the physical properties of supramolecular objects and how one can exploit them to tune the behavior of bioinspired materials. I will show that circular polycatenanes can topologically trap twist and behave similarly to supercoiled dsDNA, and that a similar effect holds for 2D sheets of rings. Finally, I will show how coarse-grained (CG) simulations of kDNA can be used together with experimental data to clarify its properties. Our results suggest that supramolecular topological objects can form a new category of highly designable structures with potential applications in supramolecular chemistry and material science.

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