From the kinetoplast DNA to bio-inspired topological supramolecular materials and back

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Supramolecular materials built of topologically interlocked polymer rings have recently gained considerable interest in supramolecular chemistry, biology, and soft matter. Two typical examples 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. 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 a relation *Twist*+*Writhe* = *constant*, typical of dsDNA rings, holds for circular polycatenanes, and that a similar effect exists in 2D sheets of rings. Finally, I will report the results of AFM measures of the kDNA, show how coarse-grained (CG) simulations of this system can be used to estimate the average linking number of the network, and how one can use CG simulations to explain the origin of the typical buckled shape of kDNA in solution. 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.