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Polyrotaxanes are molecular pearl necklaces which consist in the assembly of macrocycles (the pearls) onto linear polymer chains (the wires of the necklaces). The peculiar organization of polyrotaxanes in solution is studied in depth: Cylinders with a diameter of 12 nm and a height of 5 nm are obtained due to the assembly of numerous macrocycles. This nano-scale organization can be used for membrane applications in order to separate small molecules from bigger ones. The obtained cylinders can also be utilized as nano-fillers so as to improve the mechanical properties of polymeric materials. The particular organization of the macrocycles and the biocompatible property of polyrotaxanes can be besides interesting in the field of tissue engineering and bone regeneration.