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Tension in Highly Branched Polymers[1]

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We propose a systematic method of designing branched macromolecules capable of building up high tension in their covalent bonds, which can be controlled by changing solvent quality. This tension is achieved exclusively due to intramolecular interactions by focusing lower tensions from its numerous branches to a particular section of the designed molecule. The simplest molecular architecture, which allows this tension amplification, is a so-called pom-pom macromolecule consisting of a relatively short linear spacer and two z-arm stars at its ends. Tension developed in the stars due to crowding of their branches is amplified by a factor of z and focused to the spacer. There are other highly branched macromolecules, such as molecular brushes - comb polymers with high density of side branches, that have similar focusing and amplification properties. In addition molecular brushes transmit tension along their backbone. Adsorption or grafting of these branched molecules on a substrate results in further increase in tension as compared to molecules in solution. Molecular architectures similar to pom-pom and molecular brushes with a high tension amplification parts can be used in numerous sensor applications. Unique conformations of molecular brushes in a pre-wetting layer allow direct visualization by atomic force microscope. Detailed images of individual molecules spreading along the surface enable critical evaluation of theories of chain dynamics in polymer monolayer. Strong spreading of densely branched macromolecules on a planar substrate can lead to high tension in the molecular backbone sufficient to break covalent bonds.

[1]This work was done in collaboration with S. Panyukov, S. Sheiko, J. Brock, and A. Bacanu