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Elastomer genome: Reverse tissue engineering.[1]

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Soft elastic materials enable the creation of implants, substrates, and haptic robotic digits with mechanical properties matching those of biological tissues. Currently, polymer gels are the only viable class of synthetic materials with a Young's modulus below 100 kPa. However, the liquid fraction in the gels causes practical troubles including phase separation and solvent leakage on deformation. Herein, we have created bottlebrush and comb-like networks that are superelastic (λ =1-12) and ultrasoft (G=10^2 – 10^5 Pa), even in the absence of solvent [1]. The brush-like architecture causes an increase in the diameter of individual polymer molecules, but unlike typical filaments, the molecules remain flexible. This enables a significant decrease in the entanglement density, which reduces the limit of stiffness in dry polymer materials by 1000 times and has opened up new applications not available to stiffer materials or materials with liquid fractions [2]. The comb-like architecture offers three independently controlled parameters – side-chain length, grafting density, and crosslink density - that allow for combinatorial variations of elastomer mechanical properties impossible for conventional linear chain elastomers, e.g. simultaneously increasing rigidity and elasticity. Based on this materials design platform, we have prepared elastomers that closely match the mechanical behaviour of biological tissue. Furthermore, this architecture affords many chain-ends that are amendable for chemical modifications and enhance molecular mobility, which directly affects vital physical properties ranging from glass transition and crystallization temperatures to adhesion and permeability. [1] Daniel, W.F.M.; Burdyńska,J.; Vatankhah-Varnoosfaderani, M.V.; Matyjaszewski, K.; Paturej, J.; Rubinstein, M.; Dobrynin, A.D.; Sheiko, S.S. Nature Materials 2016, 15, 183-189. [2]Vatankhah-Varnosfaderani, M.; Daniel, W.F.M.; Zhushma, A.P.; Li, Q., Morgan, B.J.; Matyjaszewski, K.; Armstrong, D.P.; Spontak, R.J.; Dobrynin, A.V.; Sheiko, S.S. Advanced Materials 2016, DOI: 10.1002/adma.201604209

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