ARCHITECTURAL CODE FOR THE DESIGN OF ELASTOMERS WITH TISSUE-LIKE MECHANICAL PROPERTIES

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Mimicking the mechanical behavior of living tissues is vital for both biomedical devices and nonmedical applications including soft robotics, shock absorbers, protective coatings, and wearable electronics. However, the unique combination of biological softness, strength, and toughness is difficult to recreate in synthetic materials. Current design strategies are predominantly *Edisonian* – exploratory mixing of assorted polymers, crosslinking schemes, and solvents, which is both inflexible in application and imprecise in property control. Herein, we present a universal materials design platform that leverages precision engineering of *brush-like* network architectures to program biological mechanics in solvent-free elastomers [1]. By controlling a multiplet of architectural parameters, we *precisely* and *completely* replicate skin, jellyfish, and fat stress-strain properties with archetypal poly(dimethylsiloxane). This platform enables injectable elastomer technology. Furthermore, the brush-like architecture affords many chain-ends amendable for chemical modifications, which directly affects vital physical properties ranging from glass transition and crystallization temperatures to adhesion and permeability. This design-by-architecture approach lays the foundation for a configurable synthetic engine capable of encoding a broad range of mechanical phenotypes within any desired chemistry. Finally, because these materials are solvent-free, they will neither freeze in the Arctic nor dry in the Sahara. No liquid components will exist to be squeezed out in subsurface environments or to evaporate in the vacuum of outer space. This may lead to fundamental shifts in membrane technologies, structural coloration [2], adhesion [3], dielectric actuators [4], robotics [5], and self-healing applications.

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3. Ina, M. et al. "From Adhesion to Wetting: Contact Mechanics at the Surfaces of Super-Soft Brush-Like Elastomers"*ACS Macro Letters* 6, 854-858 (**2017**).
4. Vatankhah-Varnosfaderani, M.; et al. "Bottlebrush elastomers: A new platform for freestanding electroactuation." *Advanced Materials* 29, 1604209 (**2017**).
5. Sheiko, S.S. et al "Encoding tissue mechanics in silicone" *Science Robotics* 3, (**2018**)