

## Abstract

### Incorporating polyrotaxane materials in dielectric elastomer actuators

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Polyrotaxane materials composed of threaded molecular rings can be assembled into a novel type of elastomeric material that has moving cross-linking points instead of the stationary cross-linking points seen in conventional networks. These sliding cross-links impart unique mechanical properties due to a molecular scale phenomenon caused by the sliding entropy that is commonly called the pulley effect. When a force is applied to the material, the sliding cross-links dissipate stress throughout the material in a similar manner to a pulley. This allows for the design of softer elastomers with higher strains at break. Additionally, the sliding elastomers have been seen to exhibit low hysteresis during cyclic loading which has been attributed to the air-spring like behavior of the threaded cyclic rings. These mechanical properties are desirable for dielectric elastomer actuators (DEAs) where softer materials enable higher degrees of actuation and where low hysteresis is necessary for their energy efficient operation. It is thus of interest to incorporate polyrotaxane cross-linkers to existing polysiloxane based DEA platforms. Here, we propose a synthetic pathway to create polyrotaxane cross-linkers based on polyethylene glycol and  $\alpha$ -cyclodextrin that contain vinyl groups allowing them to be incorporated into polysiloxane networks through hydrosilylation. This type of curing chemistry is commonly used in silicone elastomers due to its high efficiency and selectivity.