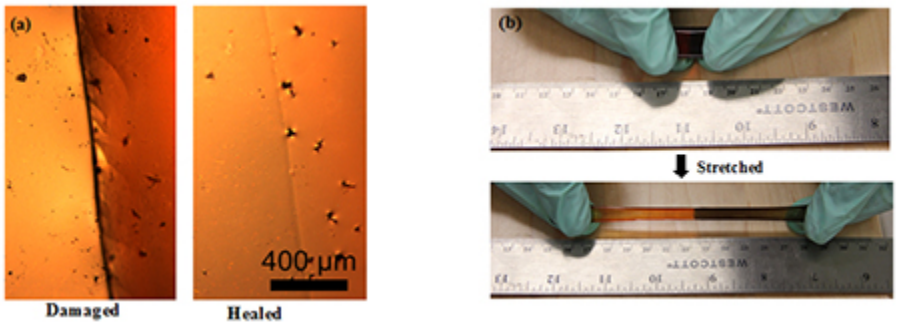
Docket #: S14-192

Ultrastretchable Self-healing Elastomer and Application as Artificial Muscle

Researchers in Prof. Zhenan Bao's laboratory have developed a high-performance, self-healing dielectric elastomer that could be used in stretchable electronics or robotic applications. This polymer network uses a combination of strong and weak metal-ligand interactions which enables a dynamic bond-breakage and re-formation process induced by strain. The resulting material achieves ultra-high stretchability as well as spontaneous healing at room temperature without any healants, plasticizers, solvents, or external energy. It also has mechanical and dielectric strength that rivals commercial rubber. This polymer could be used to greatly enhance the performance and lifetime of artificial muscle and stretchable electronics.



Self-healing properties of the polymer film. *Photographs of (a) damaged and healed samples and (b) healed film before and after stretching.*

Stage of Research

The inventors have fabricated the material and demonstrated that it can be stretched to 45X of its original length and fully recover on relaxation and it can heal >90% of its extensibility at temperatures down to -20^{o}C. They have also demonstrated its suitability for artificial muscle applications by leveraging the

polymer's high dielectric strength.

NPR "All Tech Considered" Feature
"Just Like Human Skin, This Plastic Sheet Can Sense And Heal", April 11, 2016

Stanford News Article
"Muscular Potential", April 18, 2016

Applications

- **Dielectric elastomers** with end user applications in:
  - robotics – artificial muscle to replace rigid actuators
  - stretchable electronics

Advantages

- **Ultra stretchable** - stretchable 45X (elastic) and 100X (viscoelastic) of original length with full recovery after relaxation
- **Self-healing** - spontaneous healing of >90% of its pristine extensibility at temperatures down to -20^{o}C
- **High dielectric strength** - comparable to commercial rubber
- **Long lifetime:**
  - self-healing is not sensitive to ambient aging
  - estimated to sustain stretchability over 10,000 stretches

Publications

- Li, C.H., Wang, C., Keplinger, C., Zuo, J.L., Jin, L., Sun, Y., Zheng, P., Lissel, F., Linder, C., You, X.Z., Bao, Z. "A highly stretchable autonomous self-healing elastomer", *Nature Chemistry*, published online 18 April 2016

Patents

- Published Application: 20170174842
- Issued: 10,160,835 (USA)

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