Soft Elastomers with Programmable Stiffness as Strain-Isolating Substrates for Stretchable Electronics

Min Cai, Shuang Nie, Yipu Du, Chengjun Wang, Jizhou Song

Department of Engineering Mechanics, Zhejiang University, Houzhou, Zhejiang Province, China (11724014@zju.edu.cn)

Abstract

Stretchable electronics are of rapidly increasing interests due to their unique ability to function under complex deformations. Strain isolation of stiff functional components from the substrate represents a key challenge in the development of stretchable electronics since their mechanical mismatch may yield undesirable strains to degrade the device performance. The results presented here report an approach to develop a soft strain-isolating polymer substrate with programmable stiffness by spatio-selective ultraviolet (UV) exposure for stretchable electronics. The approach compatible with the well-established lithographic process reduces the fabrication complexity significantly and offers a simple yet robust strain isolation mechanism to ensure the system stretchability of over 100%. Combined experimental and numerical studies reveal the fundamental aspects of the design, fabrication, and operation of the strain-isolating substrate. Demonstration of this concept in a stretchable inorganic metal-based resistive temperature sensor and a stretchable organic photodiode array with unusually high performance shows the simplicity of the approach and the robustness in strain isolation in both component and device levels. This type of strain isolation design not only creates promising routes for potential scalable manufacturing of stretchable electronics but also engineering opportunities for stretchable electronics involving the integration of various functional components, which require the quantitative control of the strain levels to achieve optimal performance.

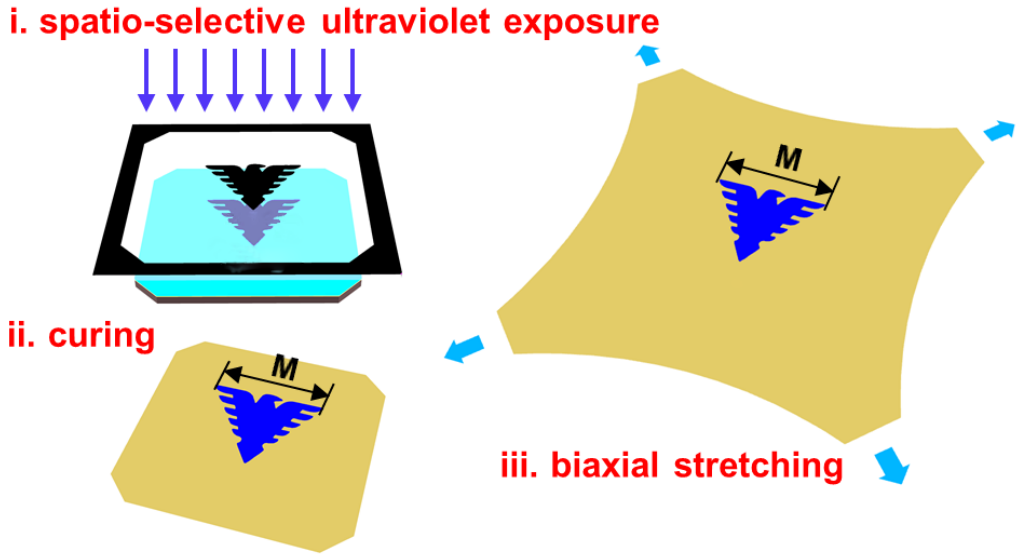

Figure 1: Spatio-selective ultraviolet exposure defines the stiffness distribution in the substrate.