Controlling the Sensitivity of Stretchable Strain Sensors with Thickness-Gradient Structure

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Abstract

Wearable strain sensors are necessary and demanded for cyber-physical systems in recent years, including personalized healthcare, human-machine interfaces, motion detection, soft robotics and other several potential applications. Development of wearable strain sensors with both high stretchability and sensitivity is required to meet such a wide range of activities for detecting large mechanical deformation and strain which are induced in the process of body motions. However, there is a trade-off between stretchability and sensitivity as the former requires intact structure which is related to ductility, while the latter requires abrupt structure change which is related to brittleness. Hence, There is a grand challenge to achieve strain sensors with both high sensitivity and large stretchability.

In this reasearch, a gradient-thickness thin film on elastic subtrate was proposed for stretchable strain sensors to solve this challenge. The gradient structure is expected to combine two contradictory properties. The rationality here is for crack-based stretchable strain sensors, thickness is a crucial parameter that can affect the crack propagation and morphologies. Large and wide cracks are easily formed in thick film with less stretchable but high sensitivity, while small and narrow microcracks are formed in thin film that are stretchable but less sensitivity. By introducing a thickness-gradient structure via thermal evaporation at tilted angles, we can obtain strain sensor that possessed gauge factor as high as 1665 at large stain (ε =27%). The stretchable strain sensors with high sensitivity and large stretchability can satisfy the various demands for several potential applications such as being used for health monitoring for caring elderly, sports, rehabilitation, and motion detection.