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RESEARCH ARTICLE

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Hydrophobic association hydrogel with toughness, high stretch, and sensitivity for flexible sensing

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Abstract

Polypyrrole (PPy), as a highly conductive polymer, is limited in application due to the difficulty of uniform dispersion in hydrogels. To improve the compatibility of PPy with hydrogels, xanthan gum (XG) is employed as an emulsifier to homogeneously disperse pyrrole (Py) in water. XG is used as a template for in situ polymerization, and PPy is coated on XG to form nanoparticles (PX) with a core-shell structure, enabling the nanoparticles to be dispersed uniformly in water for a long time. PX nanoparticles are combined with pure hydrophobic association hydrogel (HA) to form a HA/PX nanocomposite hydrogel. The HA/$PX_{2\%}$ nanocomposite hydrogels exhibiting high toughness (equivalent to 5.1 MJ/m^3) and high sensitivity (GF $= 11.07$ for 600%–1400% strain range) are prepared by combining dynamic hydrophobic cross-linking sites, as well as hydrogen bonding between PX nanoparticles and the cross-linked network. The test results show that the HA/PX nanocomposite hydrogel strain sensor has excellent strain sensing durability (800 cycles of 100% strain) and has the ability to accurately detect human joint movements for voice recognition and handwriting recognition. The nanocomposite hydrogel is a new method for the preparation of flexible electronic materials, which has great promise for application in the field of strain sensors.

KEYWORDS

gels, mechanical properties, nanoparticles, nanostructured polymers, nanocrystals, nanowires, sensors and actuators

1 | INTRODUCTION

Flexible strain sensors have gained significant attention within the field of flexible electronics due to their simple structures and ease of fabrication. Conductive hydrogels are a promising candidate for flexible strain sensors[1,2] due to their unique combination of stretchability and adjustable electrical conductivity and their excellent biocompatibility. They have the ability to convert external physical signals into detectable electrical signals for