一种用于多模式传感器和柔性微型超级电容器的多组分互联式复合纸

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摘 要:【目的】以石墨烯（RGO）、MXene 为导电碳材料，从毛竹中提取的纳米纤维素（CNFs）作为亲水剂和间隔剂，制备 RGO/CNFs/MXene 复合纸基柔性微型超级电容器（MSC）和多功能传感器。【方法】采用超声分散处理制备的悬浮液，并通过真空抽滤、水热处理构建插层结构的石墨烯/纳米纤维素/MXene 杂化电极和传感单元；最后，将其组装成自供电式可穿戴集成器件。【结果】设计的多组分互联结构为 RGO/CNFs/MXene 复合纸提供了高电导率和比电容以及稳定可靠的刺激响应能力。除了对压力、温度和光照有良好的响应外，以该复合纸为电极制备的 MSC 可以达到 148.25 F cm^3 的总体积电容 (相对于整个器件)，20.5 mW cm^3 的体积能量密度并具有良好的循环稳定性。因此，同时将复合纸用作可以感知压力/温度/光变化的多功能传感单位和微型超级电容器的电极，组装了具有良好的机械强度、可靠的刺激响应和优异的电化学电容的柔性集成设备，通过检测不同的人体信号刺激(动作、脉搏、声音和签名)，揭示了其在人体动作监测和防伪识别方面的潜力。【结论】本研究论证了利用单一功能材料制备多功能传感器和高性能微型超级电容器的可行性，为新一代便携式智能集成器件提供了重要参考。

关键词: 纳米纤维素；集成器件；柔性超级电容器；传感器

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A multicomponent interconnected composite paper for triple-mode sensors and flexible micro-supercapacitors

Abstract:【Objective】Using graphene (RGO) Mxene as conductive carbon material and cellulose nanofibrils (CNFs) extracted from bamboo as hydrophilic agent and spacer, RGO/CNFs/Mxene composite paper based flexible micro-supercapacitor (MSC) and multifunctional sensor were prepared【Method】 The intercalated RGO/CNFs/Mxene hybrid electrode and sensing unit were constructed by vacuum water extraction and heat treatment of the suspension prepared by ultrasonic dispersion treatment. Finally, it is assembled into a self-powered wearable integrated device【Result】The designed multi-component interconnection structure provides high conductivity and specific capacitance of RGO/CNFs/Mxene composite paper as well as stable and reliable stimulation response ability. In addition to a good response to pressure, temperature and light, the MSC prepared with the composite paper as the electrode can achieve a total volume capacitance of 148.25 F cm^3 (relative to the whole device), a volume energy density of 20.5 mW cm^3 and a good cycle stability. Therefore, the composite paper is used as a multifunctional sensing unit which can sense the pressure/temperature/light changes and the electrode of the MSC. The composite paper is assembled with good mechanical strength. The flexible integrated device with reliable stimulus response and excellent electrochemical capacitors reveals its potential in human motion monitoring and anti-counterfeiting identification by detecting different human signal stimuli (motion pulse sound and signature). 【Conclusion】This study demonstrated the feasibility of using a single functional material to fabricate multifunctional sensors and high-performance MSCs, providing an important reference for a new generation of portable intelligent integrated devices.

Key words: Cellulose Nanofibrils; Integrated Devices; Supercapacitors; Sensors.