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NOVEL RELATIVE HUMIDITY SENSOR

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Introduction

The study reports the design and manufacturing processes for new chemiresistive humidity sensors using conductive polyaniline- Kollidon® SR nanofibers as sensing layer. Chemiresistive humidity sensors are devices that change their electrical resistance in response to changes in humidity levels, making them valuable tools for various applications such as environmental monitoring, industrial processes, and consumer electronics. Using conductive polyaniline nanofibers as the sensing layer is a promising approach. Polyaniline is a conducting polymer known for its sensitivity to moisture, and nanofibers have a high surface area-to-volume ratio, which can enhance sensitivity and response time. The use of polyaniline nanofibers on a dielectric substrate offers several advantages for humidity sensing because polyaniline is a conducting polymer that undergoes changes in its electrical conductivity when exposed to moisture. On the other hand, the use of nanofibers of polyaniline increases the surface area available for moisture adsorption. This high surface area-to-volume ratio amplifies the sensitivity of the sensor. Even small changes in humidity levels can result in noticeable changes in electrical resistance, making the sensor highly responsive. Other features of the polyaniline nanofibers are the high surface area and porous structure of nanofibers allowing the rapid diffusion and adsorption of moisture molecules, leading to quick response time. Also, polyaniline nanofibers are known for their stability over time when exposed to humidity, which is crucial for the long-term performance of a humidity sensor. This stability is attributed to the reversible nature of the polyaniline's conductivity changes in response to moisture.

Sensor architecture

The humidity sensor includes a dielectric substrate (Lexan), a first electrode a second electrode disposed above a substrate, and a sensing layer. Synthesis of conducting polyanilines is performed by doping emeraldine with H_2PO_3-PEG5K-COOH (Mw = 5000) and poly(vinyl phosphonic acid-co-acrylic acid). The electrodes (aluminum, copper, and chromium) are deposited onto the surface of the dielectric substrate by employing different methods, such as sputtering and direct printing. The synthesized nanocomposite is deposited onto interdigitated electrodes through an electrospinning technique.

Advantages of the proposed sensing layer

The sensing layer described in this paper exhibits outstanding properties:

- H_2PO_3-PEG5K- COOH and poly (vinyl phosphonic acid-co-acrylic acid) contain acidic groups and can protonate imine nitrogen atoms in the emeraldine structure to form stable conductive polyanilines;
- both act as poly dopants, are thermally stable, and do not pose any risk to the environment;
- due to the large size counter-ion, polyanilines doped with H_2PO_3-PEG5K-COOH and poly (vinyl phosphonic acid- co-acrylic acid) are less susceptible to the dedoping;
- H_2PO_3- PEG5K-COOH and poly (vinyl phosphonic acid-co-acrylic acid) improve the mechanical properties and processability of polyanilines;
- Kollidon® SR is hygroscopic and improves the mechanical and film properties of doped polyaniline. The conductive nanocomposite-based sensing layers were investigated by applying a voltage between the two electrodes and measuring the electrical current flowing through the sensitive layer at various levels of humidity.

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