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Production of printable gas sensors based on metal-decorated carbon nanotubes for application as smart PPE on industrial workwear

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Abstract

Smart Personal Protective Equipment (PPE) represents the future of enhanced occupational health and safety, with nanotechnology playing a crucial role in the development of essential smart PPE components. Portable and Wearable gas detection systems have applications across all industrial sectors. Industrial processes typically involve the use and handling of large quantities of hazardous substances, including toxic and flammable gases. Consequently, occasional gas leaks are inevitable, posing risks to the facility, workers, and nearby populations. Accidents in confined spaces often result from inadequate PPE, such as gas sensors, which are essential for timely risk avoidance. Current gas-sensing devices tend to be bulky, costly, imprecise, and prone to saturation. This underscores the need to develop technological solutions that integrate efficient sensors into user-friendly, miniaturized devices. In this context, carbon nanotubes (CNTs) offer a promising solution due to their high surface area, exceptional electrical and mechanical properties, and ability to detect gas molecules at low concentrations when combined with metal/metal oxide particles. In this study, CNTs were decorated with various nanoparticles (MD-CNTs), and water-based printable inks were produced to facilitate the direct printing of small, flexible, and lightweight sensor devices onto industrial workwear. The primary objective is to develop highly sensitive gas sensors for use as PPE. The research focuses on the production of MD-CNTs, their printing parameters, their chemical and structural characterization, and the correlation between different structural compositions and the signals detected in the presence of specific gases.