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New nano composite chemo resistive sensor for ethylene detection: Highly tunable porosity and electrical resistance for high sensing performances

Uncontrolled ethylene emission in growth chambers, greenhouses, storage facilities and during transportation leads to fast degradation of fresh produces and consequently to a significant amount of postharvest losses. To predict the shelf life, optimize the fruit quality, and reduce in-storage losses it is of paramount importance to monitor and control the ethylene emission along the supply chain. To this end, the analysis of the fruit pre-climacteric developmental phase is particularly important. Despite their excellent sensitivity, and capability of discriminating ethylene among complex mixtures of analytes, commonly used ethylene detection methods such as gas chromatography or laser photo acoustic spectroscopy suffer from expensive, bulky instrumentation, incompatible with large scale applications in industrial horticulture, and usually are unsuitable for on-site detection. The development of miniaturized, portable, low-cost, and real-time detection chemical gas sensors, therefore, evokes strongly rising demand. Chemo-resistive sensing technologies rely on the direct reversible chemical interaction between sensing material and analytes. Interactions with the analytes lead to changes in the sensor's resistance which is proportional to the amount of analytes present. Quantification of the analytes, thus, is enabled. Due to their extraordinary mechanical and electrical properties and high aspect ratio, carbon nanotubes (CNT) are an emerging class of materials for chemical sensing of gases and volatile organic compounds. A feasible approach for obtaining significant sensor robustness and stable performances is incorporating the CNTs into a polymeric carrier, allowing for high mechanical integrity and tunable electrical resistance of the resulting nanocomposite thin film. The current research presents a new chemo-resistive gas sensor based on CNTs, embedded into porous polymeric structure. This offers rapid, low cost, reversible detection of ethylene at sub-ppm concentrations. Major challenge in this context is the dispersion of CNTs within the polymer matrix; due to their relatively large van der Waals interactions, CNTs show a strong agglomeration tendency. Recently, we have presented latex technology microfiltration fabrication approach as a new and promising approach for the fabrication of nanocomposite thin films with high CNTs dispersion level and highly tunable porosity and electrical resistance. Sensing devices which were fabricated based on the resulting tunable thin films enabled us to obtain significant and clear reversible ethylene sensing. The sensor is operational at room temperature, and is highly stable in terms of chemical, mechanical and structural changes, allowing high mechanical integrity and durability.

Biography

Guy Mechrez research group combines polymer and material science with functional nanomaterials toward the development of applicable materials. Our research activity includes basic structure-property relationships investigation of the studied systems, and implantation of the obtained knowledge for the development of functional materials for food applications. We aim to implement our significant knowledge in the field of nanocomposite materials and polymer science towed the development of new chemical sensors with high sensing performances, robustness and low cost. The chemical sensors are studied via our in-house chemoresistive sensors characterization system (CSCS). The electrical, structural, thermal and other physical properties of the studied systems are comprehensively characterized by a variety of other characterization methods and tools.

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