Charge Transport, Molecular Transport and Mechanical Characteristics of Cross-Linked Nanoparticle Composites: Applications in Sensing

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The development of transducers for the detection of physiological signals, such as the faint strain occurring at the skin surface above blood vessels through which a pulse wave passes, or the sensitive detection and recognition of volatile organic compounds (VOCs) in gas mixtures are of great importance for future devices that assist us in the field of medicine, agriculture, security, as well as environmental monitoring and protection.

Hybrid organic/inorganic composite materials of cross-linked nanoparticles own unique and tunable electronic, mechanical, optical and sorption properties, making them promising candidates for the development of high-performance sensors. Herein we report the in-depth analysis of strain-sensitive charge transport in cross-linked gold nanoparticle networks, and demonstrate their facile integration in wearable transducers for pulse and gesture sensing.[1] Additionally we show how these materials can serve as chemiresistive sensors for VOCs. Here, we investigate the tunable response dynamics of such sensors that rely on analyte-dependent molecular transport processes and employ them for analyte recognition using machine learning.[2]
Further, we demonstrate how nanocomposites can be detached from their initial substrates and deposited onto microfabricated structures, resulting in the formation of freestanding membranes. The formation of such self-suspended systems allows for characterization of their (electro-)mechanical properties[3,4] and demonstration of their use in future micro- and nanoelectromechanical systems (MEMS/NEMS), such as pressure sensors with record sensitivities[4] or electromechanical transducers for VOC detection.[5]

References:

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