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MOF-Coated 3D-Printed ZnO Tetrapods as a Two-in-One Sensor for H_2 Sensing and UV Detection

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Abstract

As the world rapidly transitions towards renewable energy sources, the use of hydrogen (H2) as a green energy carrier has become increasingly important. The various applications of hydrogen in the energy sector require sensor materials that can efficiently detect small amounts of H2 in gas mixtures. One solution is the use of a Metal-organic Framework (MOF)-functionalized oxide gas sensor, specifically a MOF-functionalized ZnO sensor. The sensor is composed of tetrapodal ZnO microparticles coated with a thin layer of MOF, which results in a core@shell composite structure. Prior to the conversion to MOF, these microparticles are 3D printed to create macroscopic sensor circuitry. The sensor demonstrated selectivity and sensitivity to 100 ppm H2 in air at an operating temperature of 250 °C. The sensor is based on crystalline t-ZnO as a core which is partially converted to ZIF-8 (zinc dimethylimidazolate, Zn(MeIM)2). MOF are a class of porous materials composed of metal ions or clusters connected by organic ligands. They have a high surface area and can be tailored to exhibit specific properties, such as selective adsorption of gases. The sensor also reliably detected H2 gas in air and is selective versus methane, acetone, butanol, and propanol. Such a selectivity is important for determining the H2 dilution level in natural gas pipelines. Analysis was performed using X-ray diffraction, SEM, UV radiation, and gas sensing measurements. This innovative two-in-one sensor for UV radiation and H2 gas has significant implications for the energy sector's transition to renewable energy sources.

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Keywords: zeolithimidazole framework, hydrogen, metal-organic framework, zinc oxide sensors, porous materials

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