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Self-powered active acetylene sensing properties by piezo-plasmonic Ag@ZnO nanoarray

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ABSTRACT

In this work, low-temperature and flexible self-powered active acetylene (C_2H_2) gas sensing has been realized from the piezo-plasmonic properties of Ag@ZnO nanowire (NW) arrays through visible light modulation. With the assistance of $3.48\text{--}21.47\text{ mW cm}^{-2}$ visible light illumination, the piezoelectric output of the Ag@ZnO NW arrays acting as a response signal shows significant improvement over the traditional resistive-type C_2H_2 sensor at room temperature. Photoexcited plasmonic Ag nanoparticles (NPs) favorably modifies the intrinsic properties and increases the carrier density in the sensing surface, resulting in a strong piezoelectric screening effect. Under 12.72 mW cm^{-2} visible light intensity (under 1.3 Hz and 6 N compressive forces), the sensor shows a sensitivity up to 51.7% at 1000 ppm acetylene at room temperature, whereas at 90°C the sensor shows a maximum response up to 83.86%. Under the same condition, an average response time of 87 sec is observed (upto 1000 ppm gas concentration) as well as a broad detection range of 25-1000 ppm and excellent selectivity. The current results demonstrate a feasible approach for developing light modulated, low-temperature self-powered active gas sensors and their potential in smart wearable, handheld, and portable applications.

Keywords

Piezoelectric; Surface plasmon; Self-powered active sensor; Ag nanoparticle; ZnO nanowires; Acetylene

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