High Performance Ammonia Gas Sensors Based on Mil-101(Cr) and Reduced Graphene Oxide (rGO) Composites

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Abstract

The integration of metal-organic frameworks (MOFs) with conductive materials has transformed the landscape of gas sensing technology. This investigation introduces a composite material comprising MIL-101(Cr) and reduced graphene oxide (rGO) that synergistically enhances ammonia gas sensing capabilities. Various rGO-MIL-101(Cr) composites, with differing weight percentages of MIL-101(Cr), were synthesized and subsequently characterized employing a range of techniques. By capitalizing on the exceptional surface area and engineered pore structure of MIL-101(Cr), coupled with the outstanding conductivity of rGO, the composite demonstrates remarkable sensitivity and rapid response kinetics. Of the synthesized compositions, rGO-20 wt.% MIL-101(Cr) exhibited exceptional sensitivity towards ammonia detection, registering a sensitivity of -18.87 for 60,000 ppm and -5.24% for 2000 ppm of ammonia gas, with a discernible response evident at concentrations as low as 1 ppm. The optimal sensitivity observed at this composition is attributed to the favourable coordination bonding between ammonia molecules and chromium nodes within MIL-101(Cr), thereby modulating the material's electrical properties. The establishment of an efficacious interface between MIL-101(Cr) and rGO facilitates efficient charge transport, enabling precise ammonia gas detection. FE-SEM and TEM analyses provide clear evidence of the existence of such an interface (Fig.1). The rGO-MIL-101(Cr) composite exhibits a distinctive synergy of outstanding sensing performance and notable stability under humid conditions, attributable to its remarkably high surface area and robust architecture. This investigation highlights the promise of MOF-based composites for advanced gas sensing applications, laying the groundwork for further exploration and development of novel sensing platforms.

References

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Figures

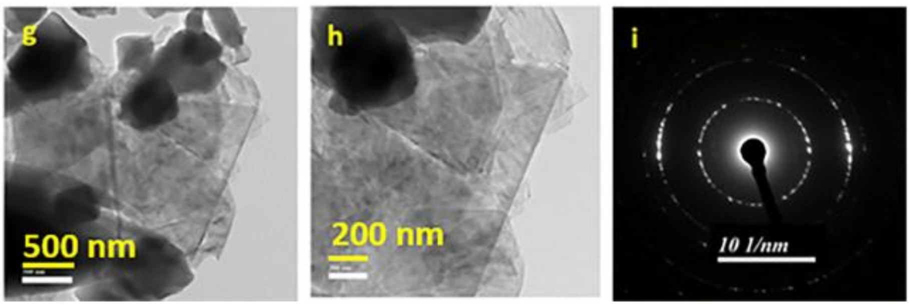

Figure 1: TEM images and SAED patterns of (g)–(i) 20% rGO/MIL-101(Cr) composite.