Nanoporous Hydrogen-Substituted Graphdiyne Gas Sensor with High Sensitivity and Fast Response

남윤태, 강호형, 정상규, 김용재, 이원무, 조수연[1], 김지한, 정희태†
한국과학기술원; [1]MIT
(heetae@kaist.ac.kr†)

Development of a high-performance chemical gas sensor is a big challenge in safety issues and diagnosis. Despite significant effort in improving sensitivity and speed, existing sensing materials are still limited based on material properties. Therefore, a new design of sensing material is highly required to overcome limitations: strong binding site, chemical tunability, and porous structure. Herein, for the first time, we demonstrate a novel gas sensing channel based on hydrogen-substituted graphdiyne (HsGDY). In addition to hierarchical nanoporous structure, this HsGDY also has abundant triple bondings which provide strong active site. The HsGDY gas sensor exhibited extraordinary sensing performance with 2 orders of magnitude higher response compared to MoS_2, GO, MXene, CNT for various gases. In particular, ultra-high sensitivity for hydrogen gas ($\Delta R/R_b$ = 278% against 1% of the hydrogen gas) were achieved with square-like fast response and recovery speed (τ_{90} = 9 sec and τ_{10} = 38 sec toward 1% of H_2), far exceeding 2D material-based gas sensors. We believe that this carbon-rich framework could open up an approach to develop high performance chemical gas sensor.