申报奖种：中国分析测试协会分析测试科学奖一等奖

项目名称：半导体传感器微纳结构增敏机理研究

主要完成人：孟凡利1，宋焱焱1，苑振宇1，孙建海2，朱洪民1，马天军2，季瀚洋1，刘洋1，许婧文1

完成人单位：1、东北大学；2、中国科学院空天信息创新研究院

项目摘要：

微纳半导体气体传感器与敏感材料界面气体扩散规律、催化能力、电子转移能力、界面吸附活性、气体吸附强度、比表面积大小、晶体尺寸等要素息息相关。揭示气体传感器微纳结构和光催化特性对传感作用的增敏机理，理解微纳结构中气体传感的反应过程，洞悉气体传感物理化学作用本质，发展新的传感机理模型，建立新的微纳敏感材料结构设计方法，为研制设计高性能气体传感器提供理论指导和技术基础，是解决低温条件下灵敏度差、检测下限不足挑战的关键。本项目在半导体传感器微纳结构增敏机理进行了系统深入地研究，提出了氧化物界面催化–石墨烯增强电子传导复合增敏新机制，发展了微结构增强气体扩散–纳结构增强吸附/催化的三维微纳结构体系增敏机制，设计了一系列高灵敏度、低检测下限的微纳结构半导体气体传感器，并在低温下实现了多种气体的 ppb 量级识别。相关成果发表在 ACS Sensors 等高水平 SCI 期刊上，10 篇代表作 SCI 他引共 314 次，受到中国工程院外籍院士、欧洲科学院院士藤岛昭教授等同行的正面引用和评价。

10 篇代表作：

1. Hongmin Zhu, Zhenyu Yuan*, Yanbai Shen, Hongliang Gao, Fanli Meng*, Highly selective and ppb-level butanone sensor based on SnO_2/NiO heterojunction modified ZnO nanosheets with electron polarity transport properties, ACS Sensors, 2023, 8, 2635-2645.

2. Yang Liu, Hanyang Ji, Zhenyu Yuan*, Fanli Meng*, Conductometric Butanone Gas Sensor Based on Co_3O_4 Modified SnO_2 Hollow Spheres with ppb-level Detection Limit, Sensors and Actuators: B. Chemical, 2023, 374, 132787.

3. Hongmin Zhu, Zhenyu Yuan*, Yanbai Shen, Cong Han, Hanyang Ji, Zhuangzhuang Mu, Fanli Meng*, Conductometric acetic anhydride gas sensors based on S-doped porous ZnO microspheres with enhanced Lewis base interaction, Sensors and Actuators: B. Chemical, 2022, 373, 132726.

4. Hanyang Ji, Wenbo Qin, Zhenyu Yuan*, Fanli Meng*, Qualitative and quantitative recognition method of drug-producing chemicals based on SnO_2 gas Sensor with dynamic measurement and PCA weak separation, Sensors and Actuators: B. Chemical, 2021, 348(1), 130698.

5. Bo Li, Minqiang Li, Fanli Meng*, Jinhuai Liu, Highly sensitive ethylene sensors using Pd nanoparticles and rGO modified flower-like hierarchical porous $\alpha-Fe_2O_3$, Sensors and Actuators: B. Chemical, 2019, 290, 396-405.

6. Haoxuan He, Chenxi Zhao, Jing Xu, Kuanzhi Qu, Zhen Jiang, Zhida Gao*, Yan-Yan Song*, Exploiting Free-Standing p-CuO/n-TiO_2 Nanochannels as a Flexible Gas Sensor with High

Sensitivity for H$_2$S at Room Temperature, ACS Sensors, 2021, 6, 3387-3397.

7. Jingwen Xu, Yong Zhang, Ting-Ting Zhai, Zeyu Kuang, Jian Li, Yongmei Wang, Zhida Gao, Yan-Yan Song[*], Xing-Hua Xia[*], Electrochromic-Tuned Plasmonics for Photothermal Sterile Window, ACS Nano, 2018, 12, 6895-6903.

8. Jingwen Xu, Ning Liu, Di Wu, Zhida Gao, Yan-Yan Song[*], Patrik Schmuki[*], Upconversion Nanoparticle-Assisted Payload Delivery from TiO$_2$ under Near-Infrared Light Irradiation for Bacterial Inactivation, ACS Nano, 2020, 14,337 -346.

9. Tianmeng Wang, Zirui Wang, Jiani Hao, Junjian Zhao, Junli Guo, Zhida Gao, Yan-Yan Song*, Improved Sensitivity and Selectivity of Glutathione Detection through Target-Driven Electron Donor Generation in Photoelectrochemical Electrodes, Analytical Chemistry, 2023, 95, 13242-13249.

10. Tingting Chen, Jianhai Sun*, Ning Xue, Xinxiao Zhang, Hairong Wang, Kaisheng Jiang, Tianye Zhou, Hao Quan, Co, N-doped GQDs/SnO$_2$ mesoporous microspheres exhibit synergistically enhanced gas sensing properties for H$_2$S gas detection, Journal of Materials Chemistry A, 2022, 10, 10759-10767.