Graphene-based Smart Gas Sensing Platform for Gas Identification at Room Temperature

Shirong Huang[1]
Alexander Croy[2], Bergoi Ibarlucea[1], Gianaurelio Cuniberti[1,3,4]
1 Institute for Materials Science and Max Bergmann Center for Biomaterials, TU Dresden, 01062 Dresden, Germany
2Institute for Physical Chemistry, Friedrich Schiller University Jena, Helmholtzweg 4, 07743, Jena, Germany
3 Center for Advancing Electronics Dresden (cfAED), TU Dresden, 01062 Dresden, Germany
4 Dresden Center for Computational Materials Science (DCMS), TU Dresden, 01062 Dresden, Germany
Contact email: shirong.huang@tu-dresden.de

Abstract

Both ammonia and phosphine are widely used in industrial processes, and yet they are noxious and exhibit detrimental effects on human health.[1] A variety of gas sensors have been developed to detect and monitor them in an industrial environment.[2,3] Despite the remarkable progress on sensors development, there are still some limitations, for instance, the requirement of high operating temperatures, and that most sensors are solely dedicated to individual gas monitoring.[4] Here, we demonstrate an ultrasensitive, highly discriminative platform for the detection and identification of ammonia and phosphine at room temperature using graphene nanosensor. Graphene is exfoliated and successfully functionalized by copper phthalocyanine derivate. In combination with highly efficient machine learning techniques, the developed graphene nanosensor demonstrates an excellent gas identification performance even at ultralow concentrations, 100 ppb NH_3 (accuracy-100.0%, sensitivity-100.0%, specificity-100.0%), 100 ppb PH_3 (accuracy-77.8%, sensitivity-75.0%, and specificity-78.6%). Molecular dynamics simulation results reveal that the copper phthalocyanine derivate molecules attached on the graphene surface facilitate the adsorption of ammonia molecules owing to hydrogen bonding interactions. The developed smart gas sensing platform paves a path to design a highly selective, highly sensitive, miniaturized, low-power consumption, non-dedicated, smart gas sensing system towards a wide spectrum of gases.

References

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个人简介：

黄时荣，博士毕业于德国德累斯顿工业大学（TU Dresden），导师 Gianaurelio Cuniberti 教授。目前在德累斯顿工业大学从事博士后研究工作，主要研究方向：基于二维纳米材料的气体传感器开发，气体吸附机理研究，气体传感信号处理分析，电子鼻（e-nose）/人工嗅觉智能传感器开发。