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Absorption and desorption dynamics of gas molecules on 2D nanomaterials observed by terahertz spectroscopy

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Electrical and optical properties of two-dimensional (2D) materials are known to be affected by the adsorption of gas molecules, which can be used for developing a highly sensitive gas sensor. Thus, any device design using 2D nanomaterials has to take into consideration absorbed gas molecules, and device performance needs to be evaluated in terms of environmental influence. In this study, we observed absorption and desorption dynamics on 2D nanomaterials such as graphene and WS2 using laser terahertz emission spectroscopy (LTES) and terahertz time-domain spectroscopy (THz-TDS). We found that the waveforms of terahertz radiation from 2D nanomaterial-coated semiconductors sensitively change with the type of the atmospheric gas and the laser illumination time. The change of the terahertz waveforms in different environmental gases can be explained by modification of the surface depletion-layer potential of semiconductors due to the surface dipole induced by the adsorbed gas molecules. Moreover, additional UV light illumination enhances the change of terahertz waveforms in oxygen, apparently due to photo-oxidation of 2D nanomaterials. We also performed terahertz time-domain spectroscopy study of graphene on various terahertz-transparent substrates at various temperatures. We found that the terahertz optical conductivity spectrum changed owing to molecular desorption from graphene. I will discuss detailed experimental results and potential of terahertz spectroscopy as an evaluation tool for 2D nanomaterials.

Biography

Iwao Kawayama received the BS, MS and DS degrees in Chemistry from Osaka University in 1995, 1997 and 2000, respectively. During 2000-2001, he stayed in RIKEN as a Postdoctoral fellow. In 2001, he joined Research Center for Superconductor Photonics in Osaka University, and this center was merged with the Institute of Laser Engineering in 2004. His research interests include development of terahertz photonic devices with superconductors, semiconductors and nanomaterials.

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