ゲルマニウム-MoS_2ヘテロ構造の作製と広帯域光応答デバイスへの応用

Fabrication of germanium-MoS_2 heterostructure for broadband photoresponsive device application

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Introduction: Heterojunction of two dimensional (2D) and bulk semiconductors has opened up new possibilities for next-generation photonic and nanoelectronic device applications. The combination of germanium (Ge) with transition metal dichalcogenides (TMDCs) can emanate new possibilities in the field of optoelectronic devices [1]. In this prospect, we demonstrate the fabrication of a Ge/MoS_2 heterostructure and observed photoresponsivity for wide wavelength range with a photovoltaic action.

Experimental: The MoS_2 layer grown by chemical vapor deposition (CVD) was used as a substrate to deposit the Ge thin film by thermal evaporation. The synthesized MoS_2 layer and Ge/MoS_2 heterostructure was analyzed by optical microscope, scanning electron microscope (SEM), Raman and X-ray photoelectron analysis. Current density-voltage (J-V) characteristics of the device was measured with a two probe system.

Results and discussion: Figure 1a-b shows the optical microscope and SEM images of the Ge and MoS_2 heterostructure. A thin interface was formed in-between the CVD grown MoS_2 and Ge film, considering the atomically smooth surface of MoS_2 layers. Figure 1d shows J-V characteristics of the Au/Ge/MoS_2/Al device for dark condition presenting the formation of a diode. The Ge/MoS_2 heterojunction showed a photovoltaic action with an open circuit voltage (V_{oc}) of 0.185 V and short circuit current density (J_{sc}) of 0.028 mA/cm^2 under illumination of light (figure 1e). The spectral response showed photoresponsivity for wide wavelength range (wavelength 350-1100 nm) signifying the possibility of developing self-powered broadband photo responsive device (figure 1f).

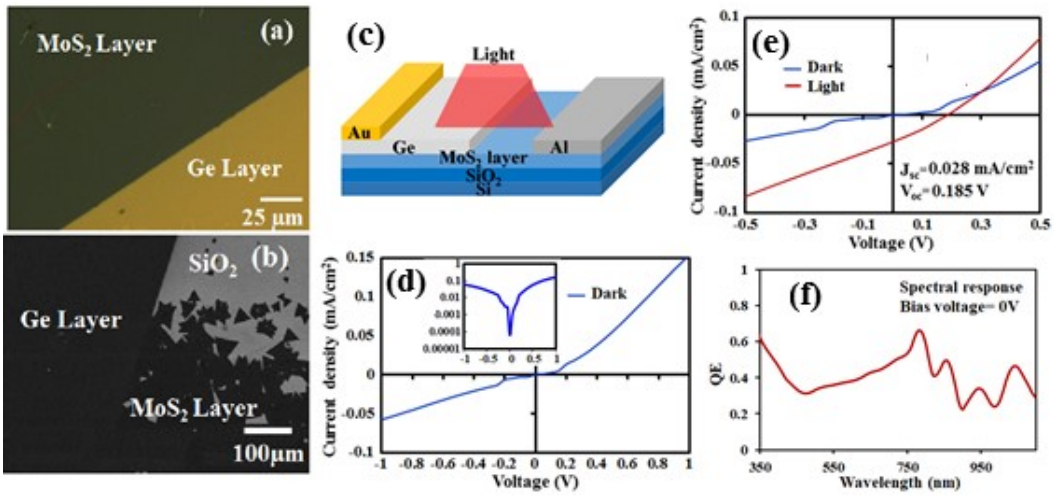

Figure 1 (a) optical (b) SEM images of Ge/MoS_2 heterostructure (c) Schematic diagram of the device. J-V characteristics (d) without illumination (e) under light illumination and dark and (f) spectral response.

[1] Y. C. Lin and J. Yoo et al., *Nanoscale*, vol. 8, no. 44, pp. 18675–18681, 2016.

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