FABRICATION OF TUNABLE BANDGAP FEW-LAYER MoS₂ FILMS AND THEIR EMERGING APPLICATION IN TANDEM CELLS

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Molybdenum disulfide (MoS₂) and other two-dimensional (2D) layered transition metal dichalcogenides (LTMDs) have attracted great interest because of their desirable electronic, photonic, and mechanical properties. Unlike conductive graphene and insulating hexagonal boron nitride (h-BN), atomic-layered MoS₂ is a semiconductor material with a direct bandgap, offering possibilities of fabricating high-performance devices with low power consumption in a straighter forward manner. A very high light absorption over a broad range of wavelength (350-950 nm) is higher than GaAs and Si which makes it the ideal materials for photonic devices. It is reported that the LTMD materials can absorb up to 5-10% of incident light in a thickness of less than 1 nm and have been shown to achieve 1 order of magnitude higher light absorption than the most commonly used solar absorbers. A tunable bandgap varying in layer thickness due to quantum confinement, demonstrates the emerging application of MoS₂ as top cell absorber for high-efficiency tandem cell. The integration of this fascinating material into practical device application requires the large-area synthesis of mono- and few-layer MoS₂ that is compatible with current micro- and nano-fabrication processes. In this work, we report a large-area growth of MoS₂ atomic layers on SiO₂ substrates via Vapor-Phase deposition. The growth of MoS₂ is carried out by chemical vapor deposition (CVD) method in a tube furnace via codepositing MoO₃ and S on a heated substrate in a flowing Ar ambient. Fig.1(a) shows an optical image of one local section with MoS₂ over 500 μm in size on the SiO₂ substrate. The Raman spectrum acquired from the grown MoS₂ samples is shown in Fig.1(b). Eₐ₂g¹ and A₁₈ vibrations characteristic of MoS₂ are evident at 380.1 and 405.3 cm⁻¹, respectively. The Si substrate Raman peak is evident at 520 cm⁻¹. The energy difference, Δ of 25.41 cm⁻¹ in the spectrum indicates the few-layers MoS₂. To explore the potential of solar systems based on the MoS₂ few layers, Si/MoS₂ (p-n) heterojunction solar cells with the intact large-area MoS₂ layers is carefully discussed.

Figure 1: (a) Optical image of one local section with MoS₂ on the SiO₂ substrate. (b) Raman spectrum of MoS₂ thin films

References

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