Scalable production of few-layer phosphorene for near-infrared light emission

Joohoon Kang

Assistant Professor
School of Advanced Materials Science and Engineering
Sungkyunkwan University

Layered semiconducting nanomaterials allow to alternate the conventional silicon based electronics due to their advantageous properties, such as unique electronic properties, relatively simple processability, CMOS compatibility, etc [1]. Even further, their unique optical properties provide more potential for III-V semiconductor based optoelectronic applications such as optical communications. For example, phosphorene, atomically-thin black phosphorus, exhibits layer-dependent direct bandgap in a wide range of infrared wavelength. However, it lacks chemical stability under ambient conditions which results in a serious oxidation issue. For practical high performance optoelectronics, it is required to produce large quantity of phosphorene without the chemical degradation. Moreover, since optical telecommunication applications requires to emit C-band wavelength (i.e., 1530 nm to 1560 nm) which corresponds to 3 to 5 layered structure of phosphorene, it is further required to sort only targeted layer thicknesses. Firstly, liquid phase exfoliation in a deoxygenated solvent system will be introduced for scalable production of chemically pristine phosphorene samples [2-5]. Subsequently, isopycnic density gradient ultracentrifugation will be discussed as a post-synthetic processing for precise structural separation of solution-processed phosphorene dispersions [6-8]. Lastly, C-band near-infrared light amplification from the phosphorene sample-silicon nanocavity hybrid structure for optical telecommunication applications [9].

References

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