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Synthesis of Two-Dimensional Transition-Metal Dichalcogenides by Mist Chemical Vapor Deposition for Field-Effect Transistors

Abdul Kuddus
Saitama University, Japan

Atomic layer two-dimensional transition-metal dichalcogenides (TMDs) have been attracted considerable interest owing to their strange properties together with unique structures that offers a wide range of applications in electronics, optoelectronics, photosensor, catalysis, spintronics and so on. The 2D-MoS_2 and WS_2 show the atomic scale thicknesses, free dangling bonds, higher chemical stability and a tunable band gap of ~1- 2 eV. In this work, synthesis of MoS_2, WS_2 and $WS_{1-x}S_{ex}$ on He-plasma treated $Al_{1-x}Ti_xOy$ has been investigated systematically by sequential Mist-Chemical Vapor Deposition (mist-CVD) and applied as channel layer of MOS-FETs. Ammonium tetrathiomolybdate $(NH_4)_2MoS_4$ and Ammonium tetrathiotungstate $(NH_4)_2WS_4$ were used as a precursor of MoS_2 and WS_2 respectively and N-methyl-2-pyrrolidone (NMP) as solvent. The prepared solution was supplied into the hot-wall reaction tube with Ar as generation and carrier gas containing H_2 (25%) at furnace temperature (Tf) of 400-600°C. Subsequently, the sulfurization (Selenization) was executed for further improving the quality of the MoS_2 or WS_2 ($WS_{1-x}S_{ex}$) flakes together with enhancing the crystallinity at Tf of 600°C for 20 min. Moreover, an efficient way of fabrication of atomic layer 2D TMDCs films with a comparable dimension is realized for the very first-time using mist-CVD with single precursor that can be applied as channel layer of MOS-FET.

Speaker Biography

Abdul Kuddus received his BSc. Engineering and MSc. Engineering in Applied Physics and Electronic Engineering from University of Rajshahi, Bangladesh in 2015 and 2016, respectively. He joined as PhD fellow in Shirai Lab, Saitama University, Japan in 2019 and continue till to date. He has over 30 publications in renowned journals that have been cited over 150 times and his current research focuses on developing a new solution-processed deposition approach Mist Chemical Vapor Deposition (mist CVD) for Two-dimensional metal dichalcogenides and their application in electronic and optoelectronic devices; MOS-FETs, Photodetector, solar cells.

e: kuddus4910@gmail.com