Growth of High-Crystalline Bulk MoSe$_2$ Using Chemical Vapor Deposition

**Na Liu**  
Soo Ho Choo, Jeong Hun Kim, Naqi Siddiqi, and Sunkook Kim  

School of Advanced Materials Science & Engineering, Sungkyunkwan University, 300, Chunchun-dong, Jangan-gu, Suwon, Republic of Korea

Contact@E-mail (naliufit9@gmail.com)

**Abstract**

Layered semiconductors based on transition metal dichalcogenides (TMDs) exhibit many distinctive characteristics, including wide band gap ($E_g > 1$ eV), high carrier mobility (>100 cm$^2$/Vs), large photoresponsivity (~500 A/W). It has been reported that MoSe$_2$ shows a higher photoresponsivity compared to MoS$_2$ because of the quantum confinement effect during the band gap transition. On the other hand, multilayer TMDs provide a wider spectral response and higher photoresponsivity than monolayer TMDs. Additionally, FETs based on multilayer TMDs offer a relatively high performance, which are expected to be more suitable for commercial fabrication process than monolayer TMDs. In this study, a highly crystalline multilayer MoSe$_2$ film was grown by CVD method directly onto SiO$_2$ substrates. Firstly, we used a relatively high pressure (>760 Torr) to form multiple nuclei during the CVD growth, resulting in multilayer MoSe$_2$ film. The fabricated multilayer MoSe$_2$ thin-film transistors (TFTs) exhibit ambipolar behaviors with reasonably large field-effect mobility ($\sim$10 cm$^2$/Vs) and high photoresponsivity (93.7 A/W). Secondly, large-grain multilayer MoSe$_2$ was synthesized using a modified CVD method. Polycrystalline compounds of MoSe$_2$ as precursor were directly vaporized onto Mo-coated SiO$_2$ substrates. The multilayer MoSe$_2$ has a relatively large grain size of several hundred micrometers. Transistors based on such MoSe$_2$ single grains show n-type characteristics with field-effect mobility up to 121 cm$^2$/Vs and on/off current ratio higher than $10^4$ on Si wafers or plastic polyimide films. The overall results of CVD-grown multilayer MoSe$_2$ offers high speed, highly photoresponsive transistor for high-performance flexible/stretchable electronics.

**References**


**Figures**

Figure 1: High-resolution TEM image of cross-sectional MoSe$_2$ film.