Preparation of Double-Gyroid Transition Metal Dichalcogenides with Mesopores and Their Potential Application

Yun Seok Choi, Yoon Yun Lee, Hwa Yong Oh and Ji Man Kim*
Sungkyunkwan University, Suwon, Korea

*E-mail: jimankim@skku.edu

Two-dimensional (2D) materials have been a hot topic of current interest since the first successful fabrication of a 2D single layered graphene in 2004. 2D layered materials exist in bulk form as stacks of slabs with weak van der Waals forces between adjacent layers. It allows exfoliation into mono- or a few layers, and exhibit interesting intercalation chemistry.

One of the 2D layered materials, transition metal dichalcogenides (TMDCs) are expected to have a great potential in nano-electronics, sensing and energy harvesting. Their layered nature and unique properties facilitate ionic or molecular intercalation, suggesting possible applications in catalysis as support, lithium ion batteries (LIBs), hydrogen storage and electrochemical double layer capacitor. Also, natural abundance and environmentally benignancy of TMDCs help facile deployment on a commercial scale in various application.

Introducing mesoporosity would be an effective strategy for the elevation of material potential to the highest pitch. Due to its high specific surface area, active site for reaction could be maximized (thermodynamic). 3D porous network provides fast diffusion path for guest species (kinetic).

Therefore, in this work, double-gyroid transition metal dichalcogenide nanostructures with 3D mesopores were successfully synthesized with KIT-6 template via melting-infiltration assisted nano-replication.

We anticipate that 3D mesoporous transition metal dichalcogenides will exhibit improved activity and selectivity in various catalytic reactions.

Synthesized 3D mesoporous transition metal dichalcogenides exhibiting high specific surface area were investigated by X-ray diffraction, nitrogen-sorption isotherms, electron microscopy and various electrochemical investigations.

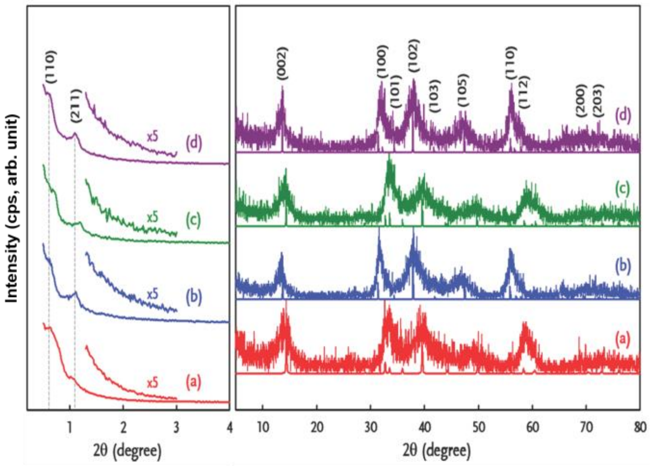

Fig. 1 Low angle and Wide angle X-ray diffraction patterns of the mesoporous (a) MoS_2, (b) $MoSe_2$, (c) WS_2, and (d) WSe_2, respectively.

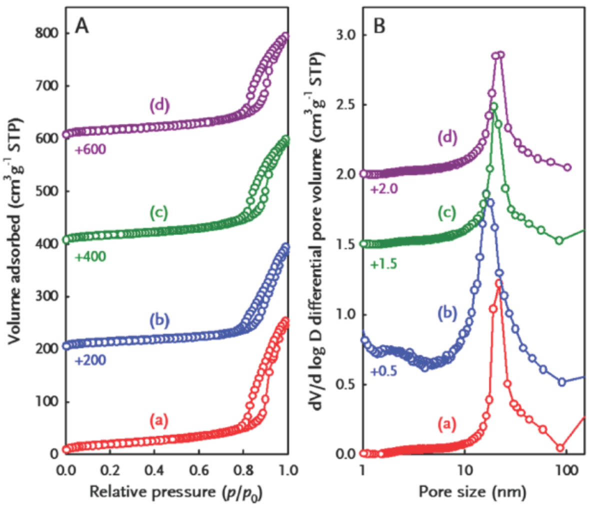

Fig. 2 (A) Nitrogen-sorption isotherms and (B) BJH pore size distribution curves of the mesoporous (a) MoS_2, (b) $MoSe_2$, (c) WS_2, and (d) WSe_2, respectively.

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