

# ENERGY AND MATERIALS RESEARCH

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### Low energy band gap materials for energy conversion and environment

Low energy bandgap semiconducting materials such as transition metal chalcogenides (TMCs) including  $\text{TiO}_2$ ,  $\text{MoS}_2$ ,  $\text{CoS}_2$  and so on have been paid attention for energy conversion and environmental issues. For the low energy semiconducting materials, we like to introduce new visible-light driven blue  $\text{TiO}_2$  materials for photo-catalytic hydrogen evolving reaction (HER) and for a removal of algae from water. In addition, we like to report new layered ternary transition metal chalcogenides (TTMCs) material to overcome to the limitation of active sites which is challenging in binary transition metal chalcogenides (BTMC) such as  $\text{MoS}_2$  towards electrochemical hydrogen production. We carefully designed the TTMC materials that contain two transition metals Cu and Mo with chalcogen S. The TTMC,  $\text{Cu}_2\text{MoS}_4$  has been successfully synthesized by a facile solution-processed method. Moreover, by anion doping such as Se in as the synthesized  $\text{Cu}_2\text{MoS}_4$ , it has been found that TTMC can be exfoliated into single layer nanosheets. Furthermore, by controlling the number of layers, single layers TTMC exhibit the highest electrocatalytic activity towards HER because the single layers can provide more catalytic active sites than multilayers and bulk. As a result, our TTMC work can guide new strategy for the developments of applications of TMCs in HER. Finally, we like to demonstrate new strategy to satisfy all requirements for the development of a highly active and remarkably durable HER electrocatalyst in both acidic and alkaline media via anion-cation double substitution into a  $\text{CoS}_2$  moiety for preparing 3D mesoporous pyrite-metal vanadium-cobalt phosphorsulphide ( $\text{Co}_{1-x}\text{V}_x\text{SP}$ ).

### Biography

Hyoyoung Lee has completed his PhD from Department of Chemistry, University of Mississippi, USA, in 1997 and did his postdoc at North Carolina State University. He worked at ETRI, Korea and then moved to Dept. of Chemistry, Sungkyunkwan University as a full Professor. He served as a Director of National Creative Research Initiatives and now as an associate director of Centre for Integrated Nanostructure Physics, Institute of Basic Science. His current research area is semiconducting materials. He has written more than 140 journal articles in top-tier journals and has been serving as an Editorial Board Member of reputed journals.

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