Facile large area growth of 2D transition metal di-chalcogenides for energy conversion applications

Antonelou Aspasia[1],[#] Govatsi Aikaterini[1], Syrrokostas Georgios[1], Leftheriotis Georgios[2], Yannopoulos Spyros[1]*

[1]Foundation for Research and Technology Hellas – Institute of Chemical Engineering Sciences (FORTH/ICE-HT), P.O. Box 1414, GR-26504, Rio-Patras, Greece

[2] Department of Physics, University of Patras, GR-26504, Rio-Patras, Greece

Presenting author: Antonelou Aspasia email:antonelou@iceht.forth.gr
* Corresponding author: Yannopoulos Spyros,email: sny@iceht.forth.gr

ABSTRACT

Two-dimensional (2D) crystals have attracted vivid research interest over the last decade owing to their unique properties in comparison to their bulk counterparts. Besides single-atom thick 2D crystals such as graphene, polyhedral thick materials whose layer thickness is dictated by the size of structural unit, i.e. transition metal di- chalcogenides, TMDCs (MoX_2, WX_2, etc., with X: S, Se, Te) can be prepared in mono- and few-layer thickness by various methods. Whilst the vast majority of the spectacular properties of TMDCs emerging as the number of monolayers decreases are so far considered adequately understood, interest is focused now on commercialization and viable applications of these materials. Essentially, the prerequisite to achieve this is the facile, reliable and low-cost preparation of substrate-wide films of controlled thickness.

Here, we show two cases of growing MoS_2 (mono and few –layers) in different substrates. At first we show that preparation of wide flexible substrate MoS_2 is achievable with easy control down to the monolayer thickness[1].The growth takes place via soft chalcogenation of commercially available Mo foils without any pretreatment by a process that is scalable to any substrate dimension. In the other case ZnO nanowires was used as a substrate and with sputtering, Mo metal was applied in different thicknesses. Using chemical vapor deposition method Mo metal was converted into MoS_2.

The above mentioned flexible substrates were used for energy applications such as counter electrodes in solar cells. The catalytic activity of MX_2 as counter electrodes (CE) has been evaluated demonstrating outstanding performance, similar to that of the more costly Pt- based CEs [2]. Moreover the core sheath structures of ZnO-MoS_2 have already tested as photo-anodes in photo-electrocemical cell for water splitting.

REFERENCES

[1] Antonelou, A.; Syrrokostas, G.; Sygellou, L.; Leftheriotis, G.; Dracopoulos, V.; and Yannopoulos, S.N. Facile, substrate-scale growth of mono- and few-layer homogeneous MoS_2 films on Mo foils with enhanced catalytic activity as counter electrodes in DSSCs. Nanotechnology, **2016**, 27, 045404.

[2] Syrrokostas, G.; Antonelou, A.; Leftheriotis, G.; and Yannopoulos, S.N. Electrochemical properties and long-term stability of molybdenum disulfide and platinum counter electrodes for solar cells: A comparative study. Electrochim. Acta, **2018**, 267, 110–121.