2D materials by Atomic Layer Deposition: Molybdenum dichalcogenides

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The success of graphene opened a door for a new class of semiconducting 2D transition metal dichalcogenides, wich have attracted considerable attention due to their layered structure, suitable band gap, electrochemically active unsaturated edges and relatively good stability against photocorrosion. These properties result promising for different applications including, hydrogen evolution reaction (HER), photocatalysis and Li-ion batteries. Apart from the widely studied 2D MoS_2, 2D selenide and telluride equivalents, $MoSe_2$ and $MoTe_2$, have recently gained considerable interest due to their higher electrical conductivity, wider inter-layer distance and narrower bandgap as compared to MoS_2, high surface area and close to zero Gibbs free energy edges for hydrogen adsorption. Unlike sulfide dichalcogenides, the lack of Se and Te precursors have prevented the synthesis of selenide and telluride dichalcogenides by ALD. In order to overcome such impediment, we present a set of novel in-house synthesized Se and Te compounds, which were successfully combined with commercial Mo precursor to synthesize $MoSe_2$ and $MoTe_2$ by ALD [1-5].

The as-deposited ALD MoS_2, $MoSe_2$ and $MoTe_2$ on substrates of different nature were extensively characterized by different techniques, which confirmed the chemical composition and revealed the growth of 2D flaky nano-crystalline MoS_2, $MoSe_2$ and $MoTe_2$. In parallel, MoS_2, $MoSe_2$ and $MoTe_2$@TiO_2 nanotube layers (TNTs) heterostructures were fabricated in a simple and fast fashion to explore and exploit the MoS_2, $MoSe_2$ and $MoTe_2$ photo- and electrocatalytic properties. TNTs act as excellent photoactive supporting material providing a high surface area, unique directionality for charge separation, and highly effective charge collection. The presentation will introduce and describe the synthesis of the 2D Mo dichalcogenides, the corresponding physical and electrochemical characterization and encouraging results obtained in HER [4,5], photocatalysis [4-6] and Li-ion batteries [7].

References

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