Controlled chemical functionalization toward 3D-2D carbon nanohorn-MoS_2 heterostructures with enhanced electrocatalytic activity for protons reduction

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Development of novel heterostructures provides an efficient way to modify the properties of individual nanomaterials giving them enhanced characteristics. In this manner, effective association of carbon nanohorns (CNHs) owning large specific surface area and electrical conductivity, with MoS_2 possessing inherent electrocatalytic activity but missing robust interactions can promote electrocatalytic reduction of protons to molecular hydrogen.[1] In this work, we proceeded with a stepwise approach for the covalent incorporation of functional groups at the conical tips and sidewalls of CNHs, along with the basal plane of MoS_2 to realize the 3D-2D CNH-MoS_2 heterostructure.[2] 3D-2D CNH-MoS_2 showed excellent electrocatalytic activity for hydrogen evolution same to that of commercial Pt/C due to plenty active sites and increased MoS_2 loading onto CNHs improving charge transfer in interfacing CNHs. The new heterostructure registered the same onset potential as Pt/C, small Tafel slope, low charge-transfer resistance and excellent stability. We therefore believe that the advanced modification route that led to the new heterostructure can open new pathways for the development of functional nanomaterials.

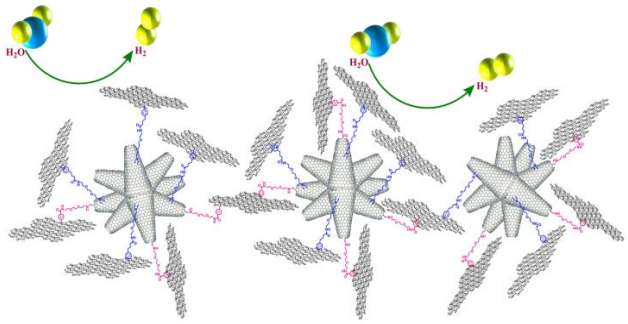

Fig 1. Schematic presentation of 3D-2D CNH-MoS_2.

References
1. A. Kagkoura, N. Tagmatarchis, *Nanomaterials* **2020**, *10*, 1407.
2. A. Kagkoura, R. Arenal, N. Tagmatarchis, *Adv. Funct. Mater.* **2021**, *31*, 2105287.