Fabrication of MoS_2 and p-type Silicon Heterojunction for Photocatalytic Hydrogen Evolution Reaction in Acidic Medium

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Introduction: Recently two directional layered materials have been explored as novel photocatalyst for hydrogen generation and several other applications. Among these, n-type molybdenum disulphide (MoS_2) is being widely studied for its excellent tunable optoelectronic and photochemical properties. It has a direct band gap of 1.8 eV which makes it a promising candidate in future of optoelectronic devices. Again, it can be combined with conventional semiconductors like silicon to fabricate a two dimensional/ three-dimensional (2D/3D) heterojunction for optoelectronics and photocatalytic application. In this study we explored the fabrication of a 2D/3D heterojunction and the photocatalytic hydrogen evolution reaction (HER).

Experimental: Molybdenum Oxide (MoO_3) was deposited on the surface of p-type Silicon using thermal evaporator. MoS_2 was deposited in a Sulphur rich condition. The reverse side of the p-type Silicon was roughened and ohmic contact was made using Indium-Gallium mixture. Connection was given using a copper wire. An epoxy resin layer was coated on top of it. A linear sweep voltammetry analysis was done of the device thus made, in 0.5 M Sulphuric acid (0.5M H_2SO_4) in dark and light conditions to check the light response of the device.

Results and discussion: Figure 1a shows the schematic of a MoS_2 and p-type Silicon heterostructure. Figure 1b shows the Raman spectrum of the synthesized MoS_2 and p-type Silicon heterostructure by the sulfurization process. Formation of few-layers MoS_2 on Silicon wafer surface was confirmed. Figure 1c shows the hydrogen evolution reaction in the 0.5M H_2SO_4 using the MoS_2/Si as photocathode. It is evident that the device showed an increase in current when it was exposed to light. The potential at which hydrogen evolution began also decreased in the presence of light.

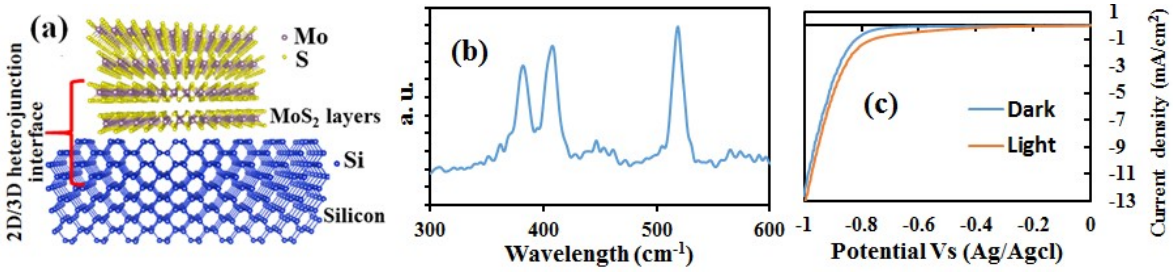

Figure 1 (a) schematic of a MoS_2 and p-type Silicon heterostructure, (b) Raman spectrum of the synthesized MoS_2 on p-type Silicon wafer (c) e hydrogen evolution reaction in the 0.5M H_2SO_4 using the MoS_2/Si as photocathode under dark and light illumination.