On the role of capillaries and electronic structure of MoS_2 phases in hydrovoltaic energy

Suvigya Kaushik
Gopinadhan Kalon
Indian Institute of Technology Gandhinagar, Palaj, Gujarat, India - 382355
kaushik_suvigya@iitgn.ac.in

Abstract

The development of sustainable and cost-effective solutions suggests a significant stride towards realizing global energy initiatives. Recently, hydrovoltaic energy, which generates electricity from nanomaterials upon contact with water, has surfaced as an eco-friendly technology. However, studies till now primarily focused on exploring carbon nanomaterials or conducting materials with functional groups. Moreover, the role of electronic structure in hydrovoltaic energy remains poorly understood. In this study, we investigate the potential of MoS_2, with its two electronic phases, metallic 1T' and semiconducting 2H [1], as a model system for hydrovoltaic energy. The metallic phase was synthesized via a chemical exfoliation route [2] and made into laminates, then converted to the semiconducting phase by annealing. The power density obtained from metallic 1T' laminates (interlayer spacing: 12.1 Å) was as high as 1 W m^{-2} as compared to 50 mW m^{-2} of semiconducting 2H laminates (interlayer spacing: 6.2 Å). Through this study, we infer that capillaries and electronic structure are crucial factors in hydrovoltaic energy generation, along with conductivity and hydrophilicity. This study paves the way for further investigations in the field of water evaporation-induced electricity, opening new avenues for sustainable energy generation.

References

[1] Kaushik, Suvigya, et al. "High-yield exfoliation of MoS_2 nanosheets by a novel spray technique and the importance of soaking and surfactants." *Nano-Structures & Nano-Objects* 32 (2022): 100922.
[2] Hu, C. Y., et al. "pH-dependent water permeability switching and its memory in MoS_2 membranes." *Nature* 616.7958 (2023): 719-723.

Figures

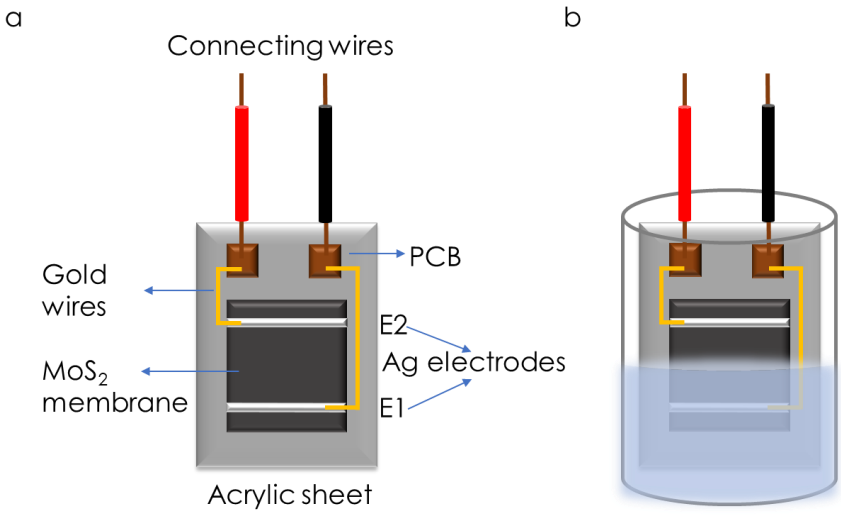

Figure 1: Hydrovoltaic energy generation from MoS_2 laminates. a. Schematic of the device. b. Device in contact with water.