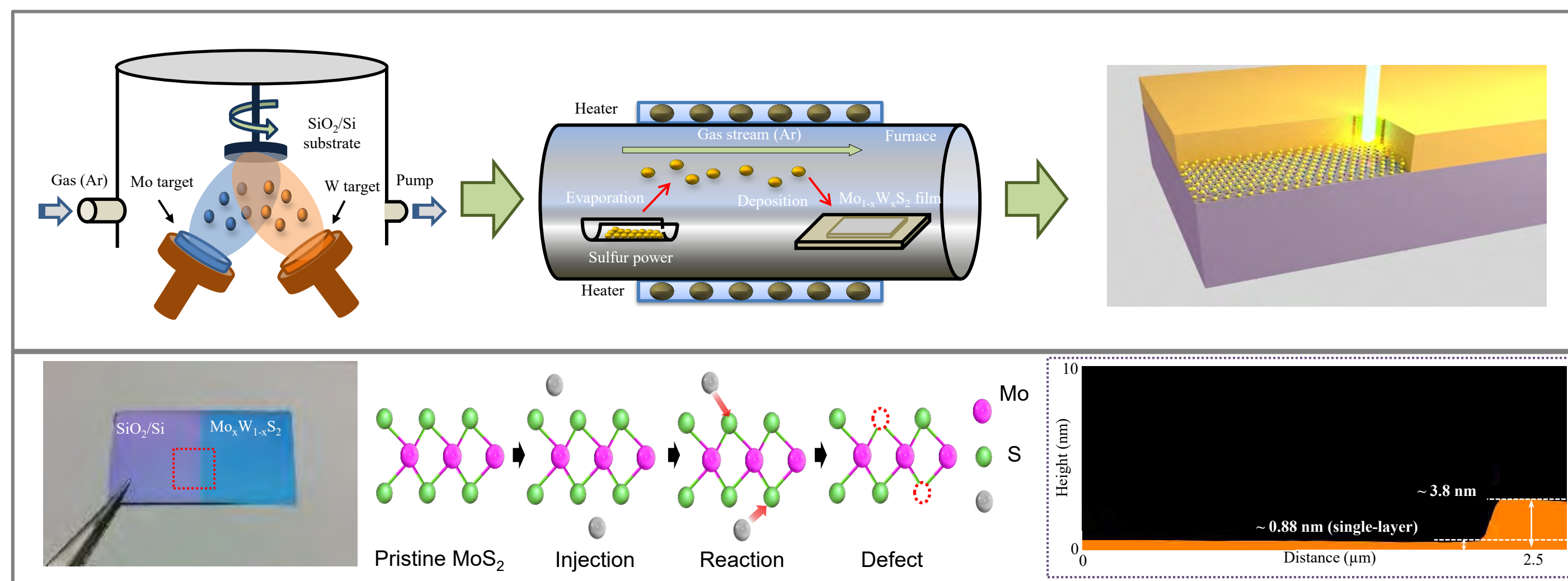
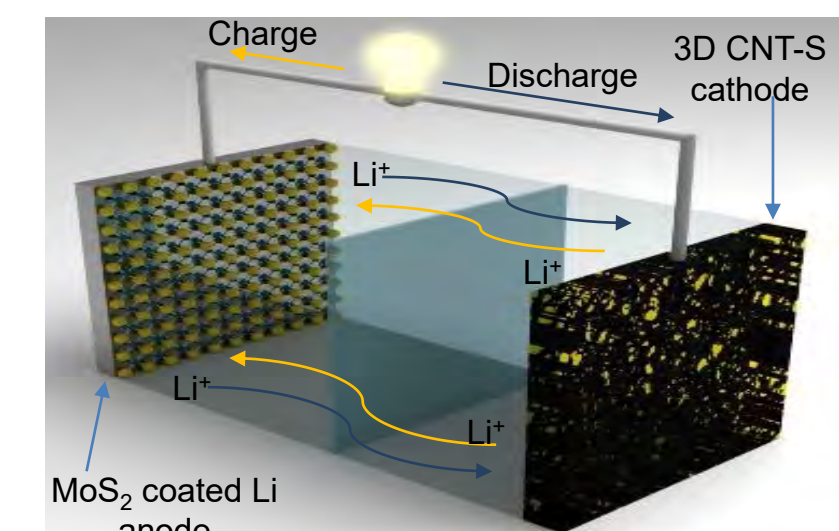


# 2D TMDs: Alloying and Defect-Engineering

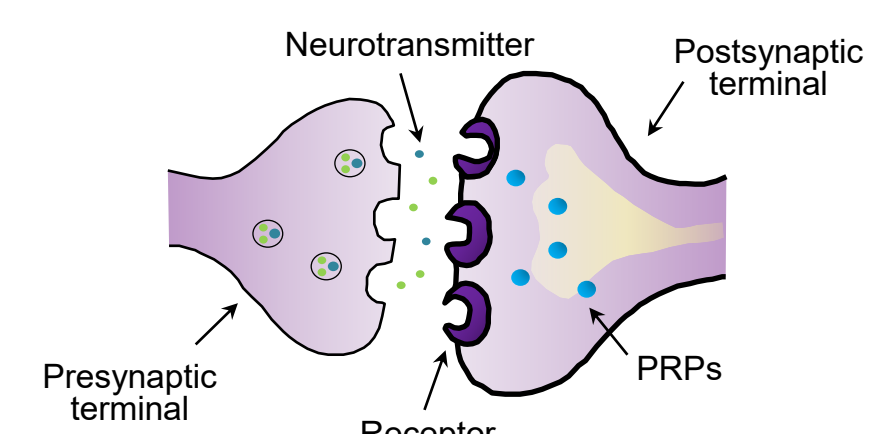
We are conducting basic and applied research at the frontier of nanomaterials and their applications in rechargeable batteries, nanoelectronics, and bioelectronics. Our passion lies in the discovery, understand and application of new paradigms to enable next generation devices and systems that can address societal needs.



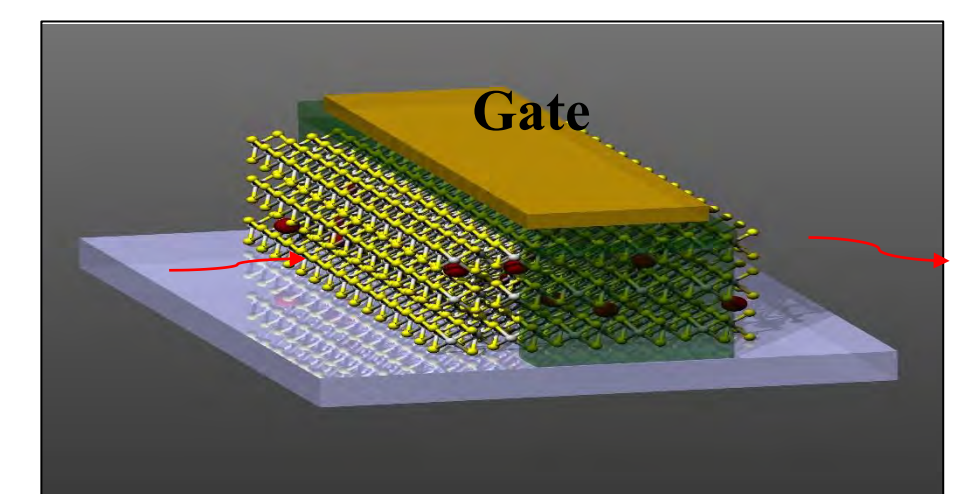
Synthesis of 2D Materials & Engineering



(Batteries)



(Neuromorphic/Piezoelectricity)



(Ion Gating)

Applications of 2D Materials

[ACS Nano 12, 6, 6301-6309 \(2018\)](#)

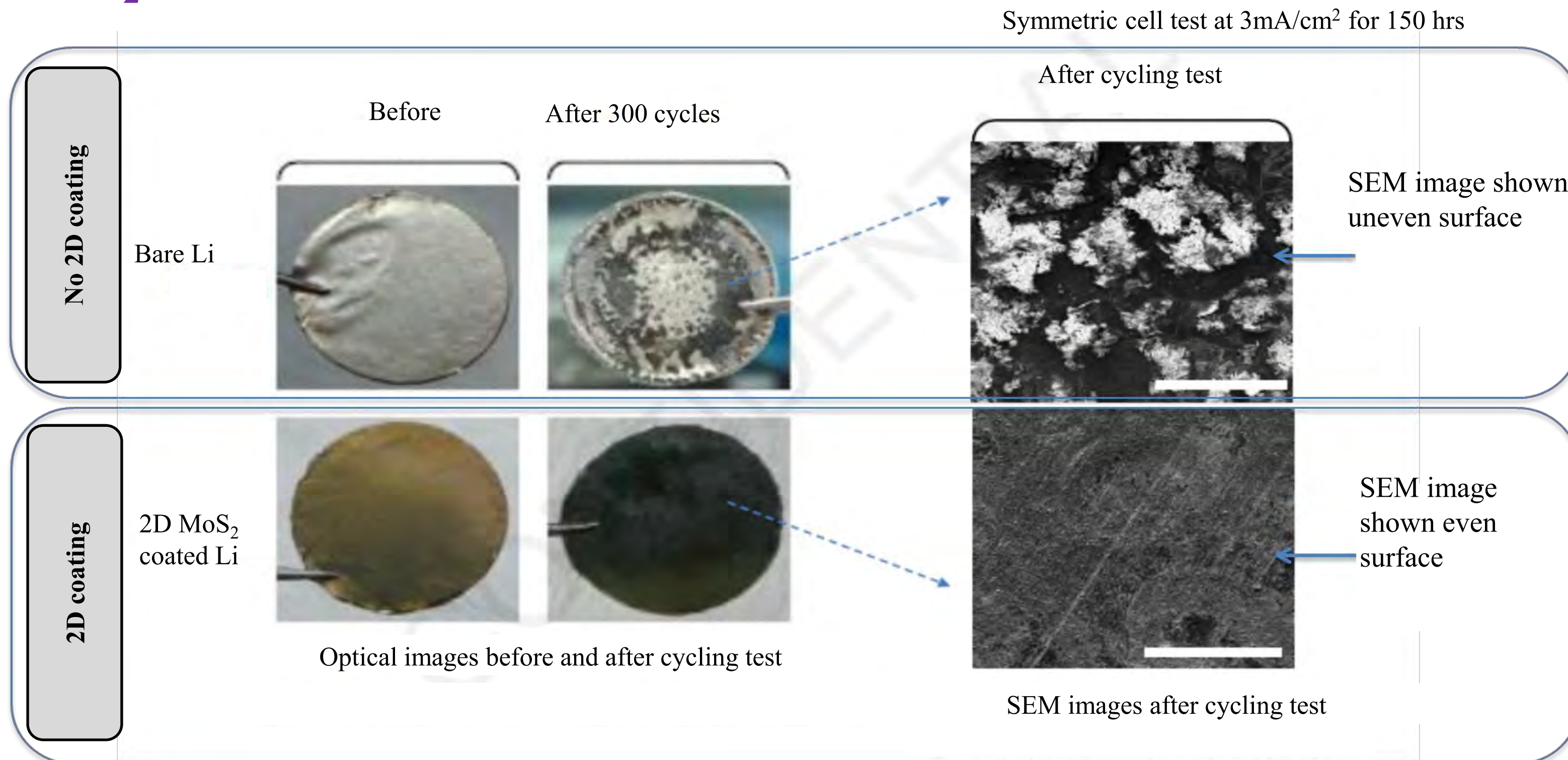
[Scientific Reports, 7, 16121 \(2017\)](#)

[ACS Appl. Mater. Interfaces, 6 \(23\), pp 21215 \(2014\)](#)

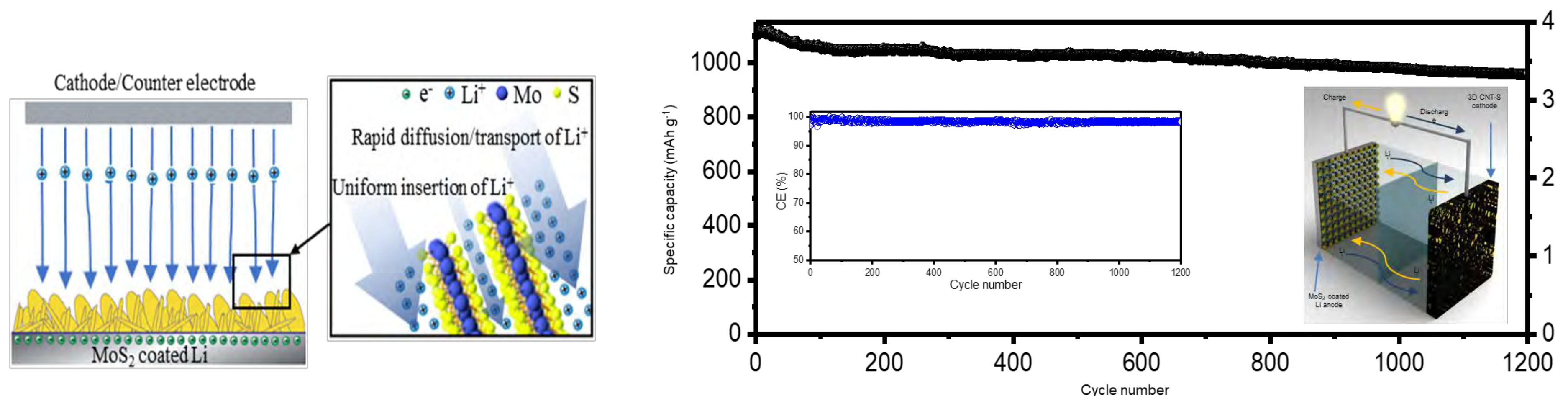
[Materials Today, 116-130, 20, \(2017\)](#)

# Advanced Rechargeable Batteries

## MoS<sub>2</sub> coated Li-metal Anode



- Dr. Choi's team developed a scalable method to coat 2D MoS<sub>2</sub> layer on Li metal.
- The dendrite formations are effectively suppressed.

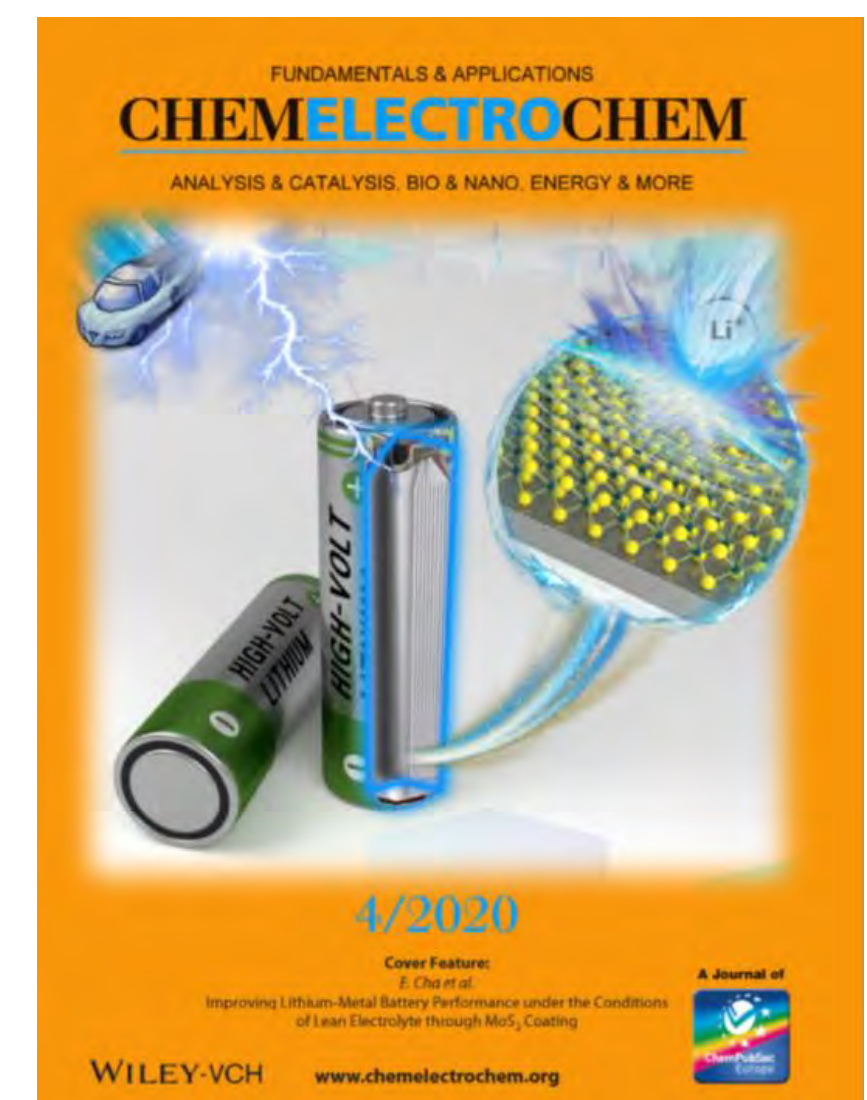
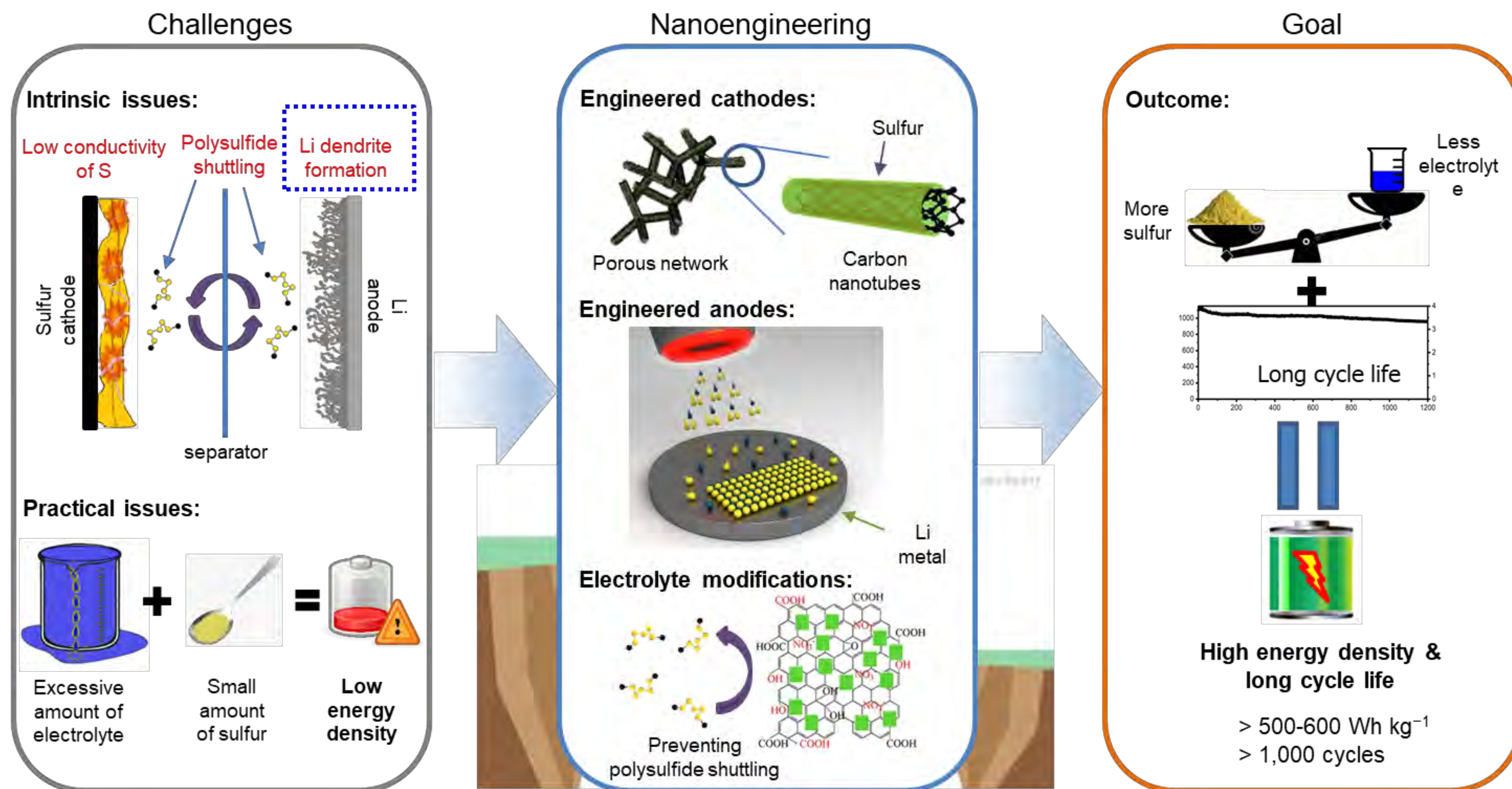


Long-term cycling performance of Li-S battery with Dr. Choi team's anode measured at 0.5 C for 1,200 cycles. The average specific capacity decay is 0.013% per cycle with capacity retention of >80% at 1,200th cycle.

Nature Nanotechnology, 13, pages337-344 (2018)

# Development of Advance Battery Technology

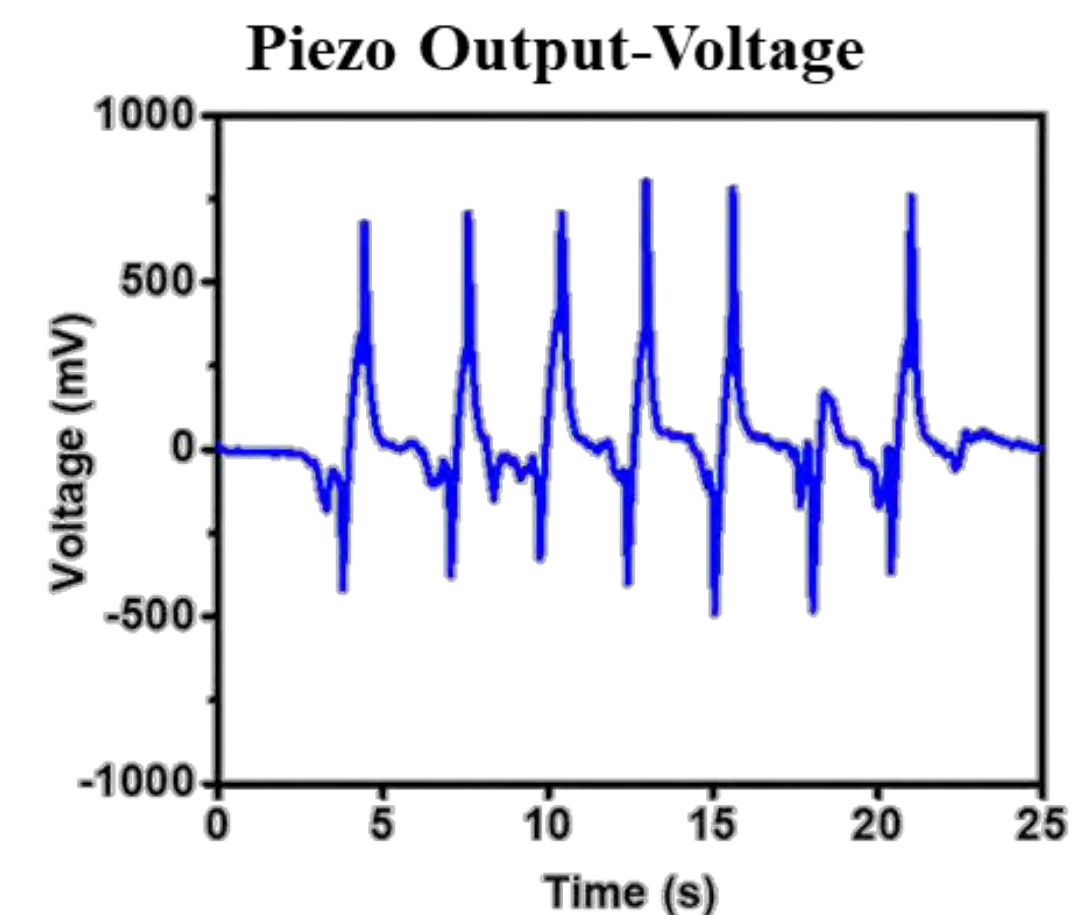
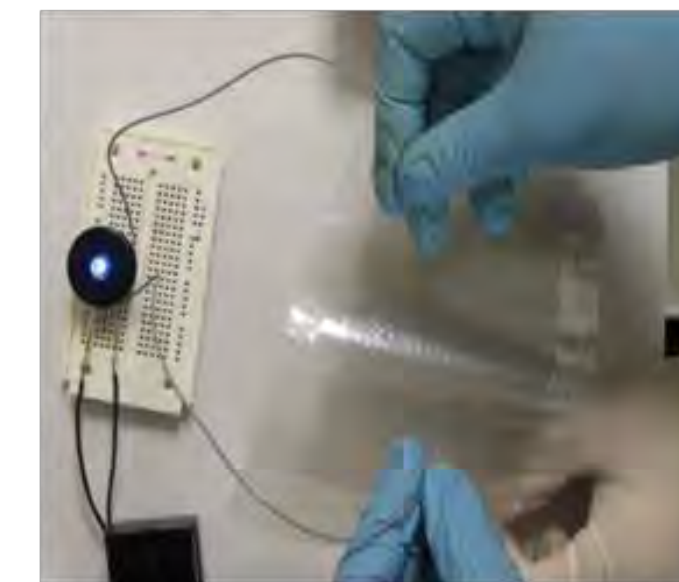
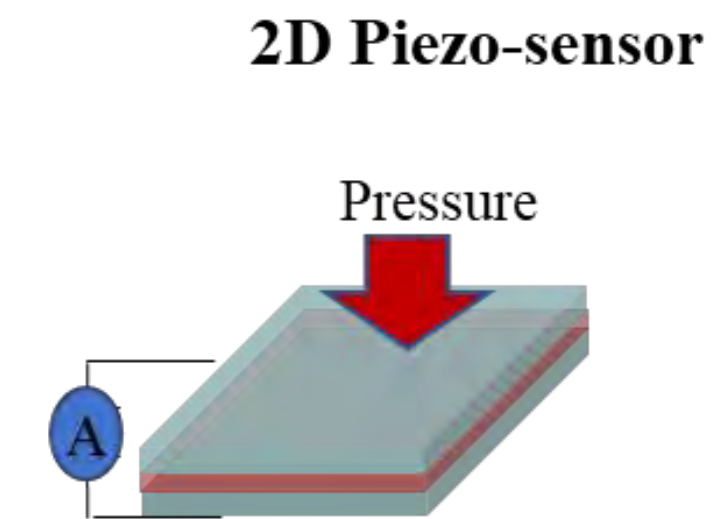
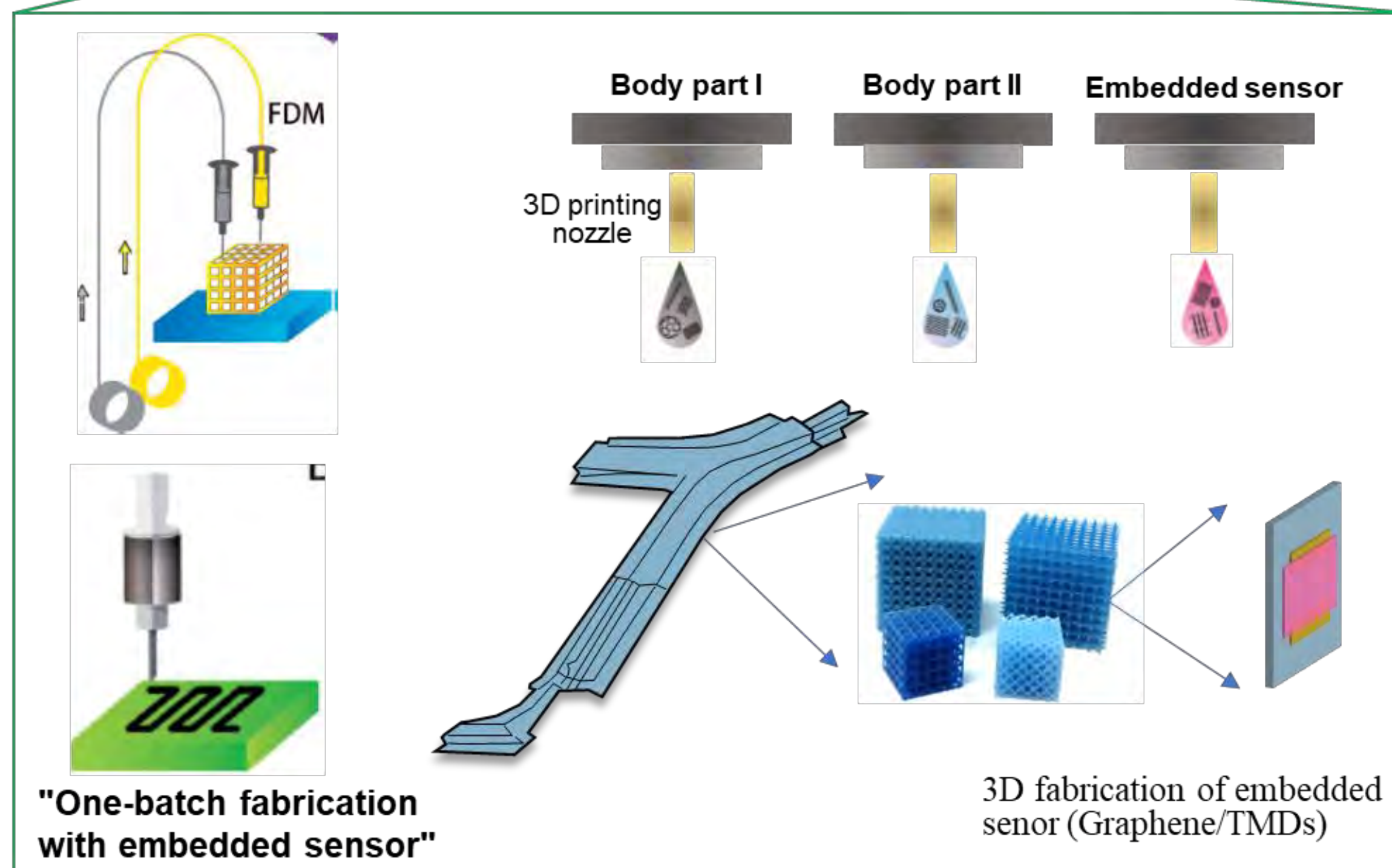
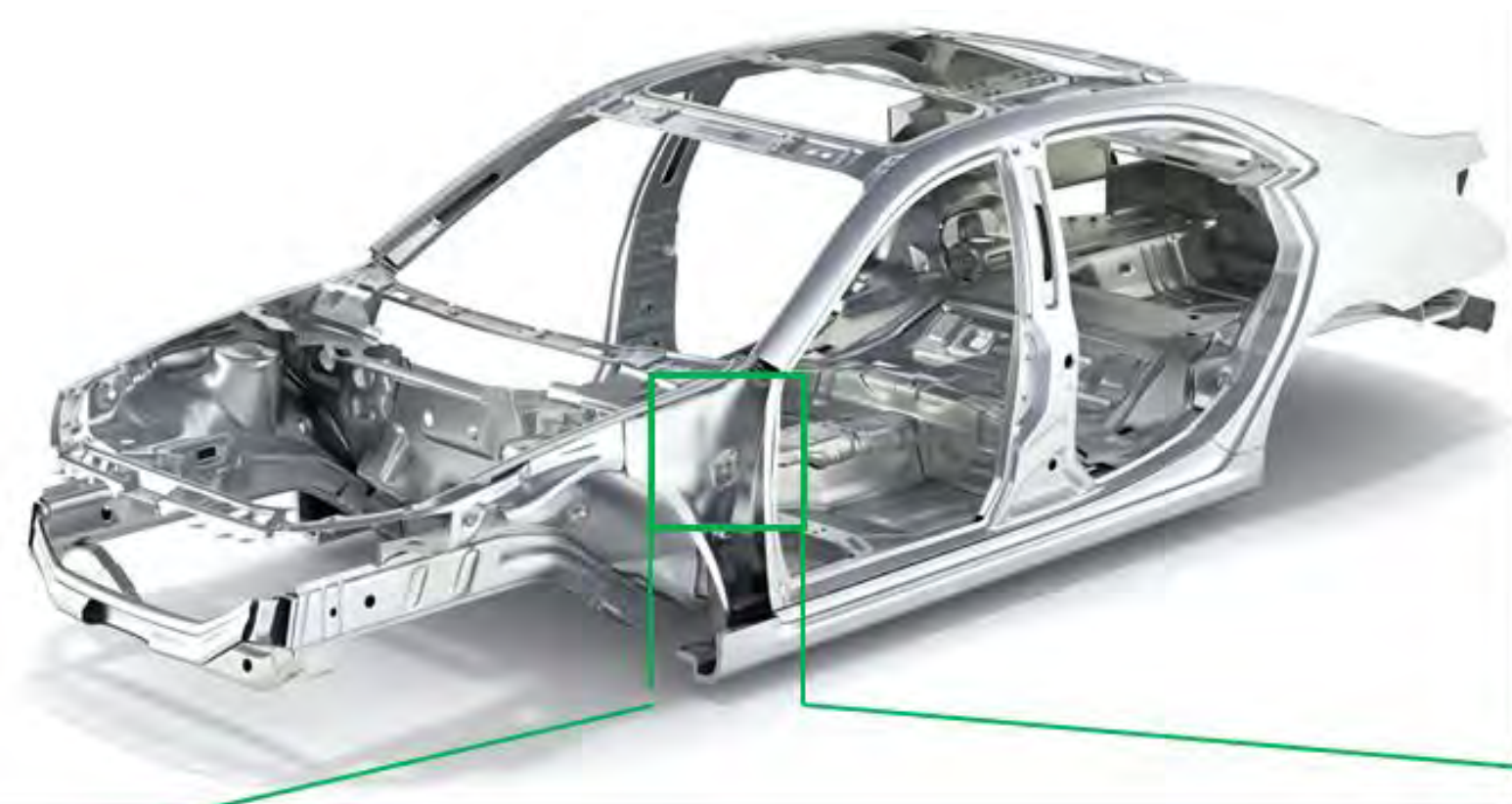
We are currently developing each component in Li-S batteries that are developed to enhance the electrochemical properties of sulfur cathodes, lithium anodes, or electrolytes; we also develop several important strategies of nanoengineering and how they address the practical limits of Li-S batteries that prevent them from making commercial products.



[Journal of Power Sources 511 230426 \(2021\)](#)  
[Nanoscale Horizons 5\(5\):808-831 \(2020\)](#)  
[Nature Nanotechnology, 13, pages337–344 \(2018\)](#)

# 3D Printed Embedded Sensor & Batteries

There are great number of demands for embedded sensors and powering sensor devices. 3D printed all solid-state metal-ion batteries are proposed to be printed conformally on a device structure seamlessly. Our research involves development of flexible sensors and high-performance solid-state metal-ion rechargeable batteries.



[Additive Manufacturing, 48, 102419 \(2021\)](#)  
[Scientific Reports, 11 14330 \(2021\)](#)

# 2D Nano-devices: Piezoelectric sensor, Neuromorphic memory devices

We present metal-ion assisted 2D MoS<sub>2</sub> neuromorphic devices fabricated by using a simple sputtering method. This method enables us to synthesize large-scale and uniform nanostructured polycrystalline MoS<sub>2</sub> film on flexible substrates. We found that the small grain of MoS<sub>2</sub> film effectively enhances the ion transport through the grain boundaries or interfaces in the MoS<sub>2</sub> film, which results in excellent neuromorphic characteristics such as bipolar electrical property, short-/long-term plasticity (STP/LTP) with a high ratio of  $I_{\text{LRS}}/I_{\text{HRS}}$  ( $\sim 10^5$ ), paired-pulse facilitation (PPF), and stability. This work provides insight for realizing practical neuromorphic devices and understanding ion-mediated synaptic behavior of nanocrystal structures, which can be tuned for high-efficiency neuromorphic devices.

