Optimized Growth Conditions of MoS$_2$ Nanoflowers for HER Evolution

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Introduction

Climate change induced by anthropomorphic activity has driven the search for sustainable sources of energy. Many of these technologies are limited by the slow reaction kinetics of the oxygen reduction reaction (ORR) and hydrogen evolution reaction (HER) which demand expensive metal catalysts for practical use. Herein, inexpensive MoS$_2$ nanoflowers are grown and have the potential to catalyze many of the reactions required for future sustainable energy applications.

Methods

The MoS$_2$ nanoflowers were grown via powder vapor disposition (PVD) from precursor molybdenum oxide and sulfur chips on flexible graphite paper. Various conditions were investigated for optimal growth including argon flow, temperature, time, and pressure.

Results

Figure 3: (left to right) The graphite paper substrate before and after the growth. The purple color indicates the growth of the flowers.

Figure 4: FESEM surface image of the nanoflowers

Figure 5: Raman spectra of the substrate surface after growth. The $E_{2g}$ and $A_{1g}$ vibrational modes of MoS$_2$ at 380 and 406 cm$^{-1}$, respectively show high quality MoS$_2$ growth.

Discussion and Conclusion

Figures 3-5 suggest the presence of MoS$_2$ nanoflowers. Optimal growth seems to occur at conditions of 200torr, 200sccm, 800°C, and 30min for pressure, flow rate, temperature and bake length, respectively. Given the system drift inherent in PVD techniques, these conditions vary over time even when using the same equipment.

Owing to the increased edge sites of the MoS$_2$ nanoflowers, these substrates are expected to catalyze various reactions. Electrochemical techniques such as cyclic voltammetry and linear sweep voltammetry should be deployed to conduct the catalytic characterizations of these nanostructures.

References
