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# Nucleation and Growth of $MoS_2$ Crystals on GaN and 4H-SiC Substates Using Ammonium Tetrathiomolybdate Precursor

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## 1. INTRODUCTION

Transition metal dichalcogenides (TMDCs) layered materials have recently attracted significant interest owing to its excellent optoelectronics properties for device applications. Various studies have shown that the $MoS_2$ is a promising layered material for optoelectronics and visible light photocatalytic application. Similarly, both GaN and SiC has recently investigated for efficient photocatalytic application and hydrogen generation. In this prospect, two-and three dimensional heterointerface of $MoS_2$ layer with GaN and SiC can be significant to boost the photocatalysis activity by broadening photoresponsive wavelength.

## 2. EXPERIMENTAL DETAILS

The synthesis of $MoS_2$ layer on SiC surface was performed as per the following steps. Firstly, the Ammonium Tetrathiomolybdate [$(NH_4)_2MoS_4$] was dissolved in N, N-Dimethylformamide super hydrated solution (DMF) (1mg/1ml or approximately 0.1 wt. % solution) and later it was sonicated for 10 min. This solution was then spin-coated onto the surface of GaN and SiC substrate at 2000 rpm for 60 sec. Later the substrate was kept in quartz tube of length 80 cm, along with sulphur powder in two different temperature furnaces, separately. Hydrogen ($H_2$) gas flow was introduced into the quartz tube. Sulphur evaporated in LTF (Low temperature furnace) at 220° Celsius reacts with the Ammonium Tetrathiomolybdate to form $MoS_2$ layers on the GaN and SiC substrates, respectively, in HTF (high temperature furnace) which is heated to 750° Celsius.

## 3. RESULTS AND DISCUSSION

The lattice mismatch between the $MoS_2$ and GaN substrate is 0.8% and with 4H-SiC is around -2.9%. It signifies possible growth of oriented $MoS_2$ crystals with GaN and disoriented with that of SiC. Figure 1a shows the Raman spectra of the $MoS_2$/4H-SiC heterostructure sample. The characteristic $E_{2g}$ and $A_{1g}$ peaks corresponding to $MoS_2$ layer were observed with a peak difference (Δ) of 24 $cm^{-1}$, along with the GaN and SiC characteristic peak of the two different substrates, respectively.

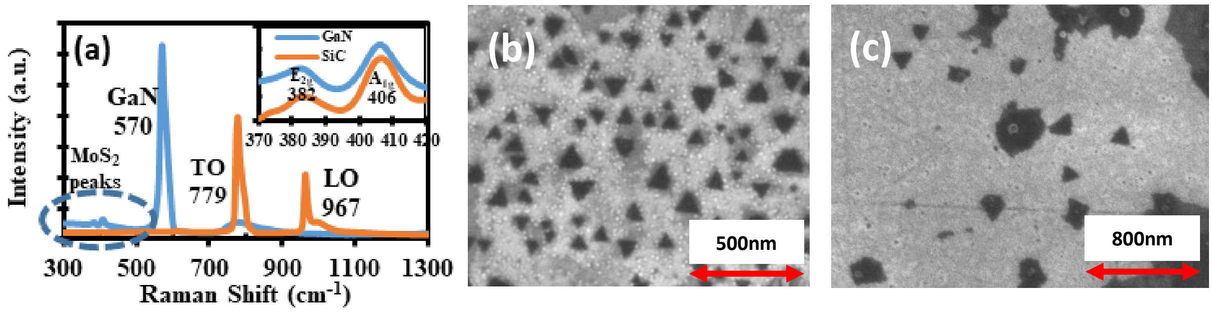


Figure 1: Raman spectra of (a) $MoS_2$ crystals on two different substrates, namely, GaN (blue line) and SiC (orange line). Here, inset shows corresponding peaks of $MoS_2$. SEM image of $MoS_2$ crystal on (b) GaN and (c) SiC

## 4. CONCLUSION

In conclusion, we have demonstrated growth of optically active $MoS_2$ crystals on lattice matched GaN and 4H-SiC substrate using ammonium tetrathiomolybdate precursor in a CVD process. The nucleated triangular $MoS_2$ crystals shows epitaxial growth on GaN and misorientation due to a lattice mismatch on SiC. Understanding the growth nature of $MoS_2$ crystals on GaN as well 4H-SiC can be the key to develop effective heterostructure for optoelectronics and photocatalysis application.