Raman characterization of MoS_2/Graphene lamellar heterojunctions to develop flexible electronics

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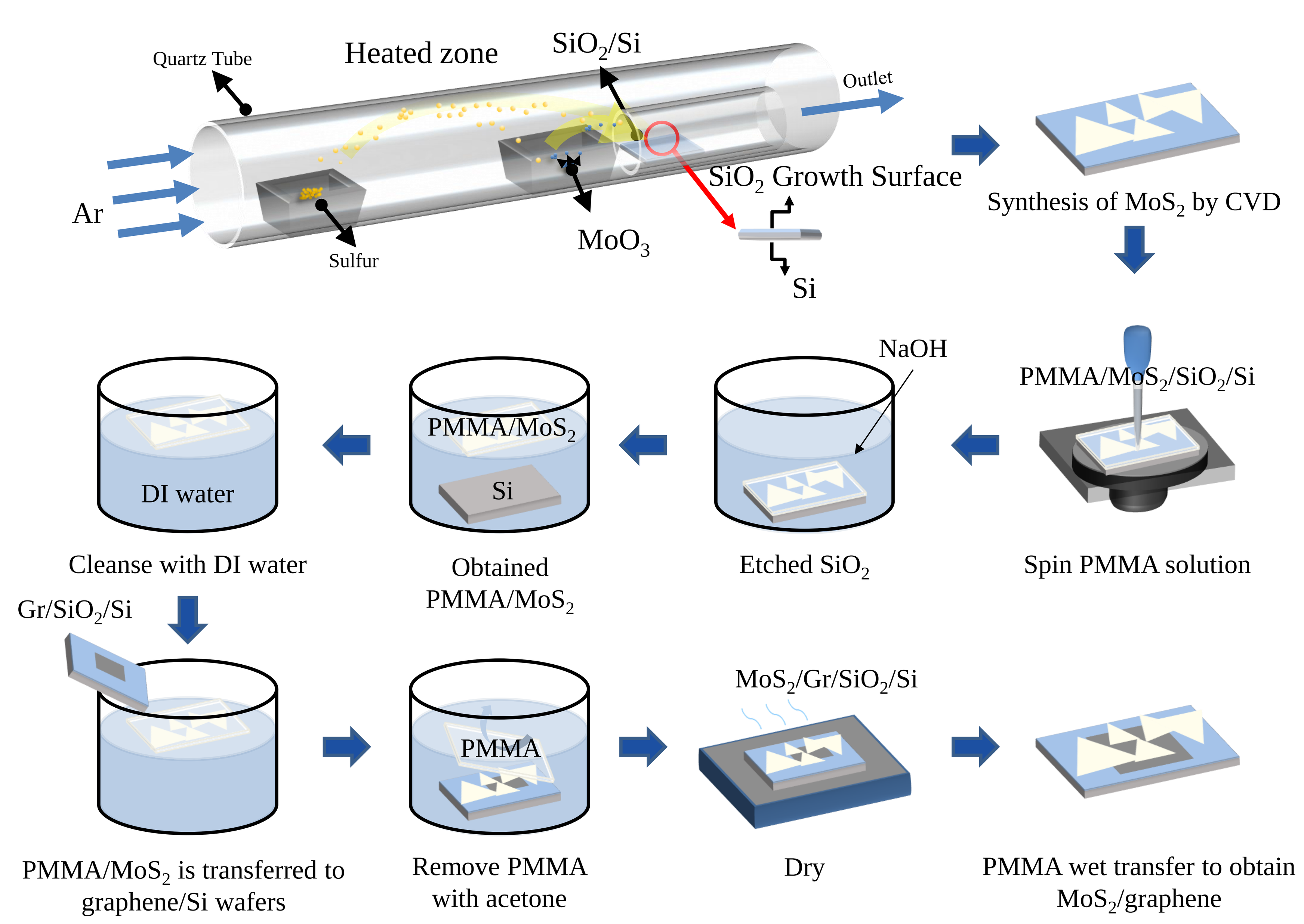
INTRODUCTION

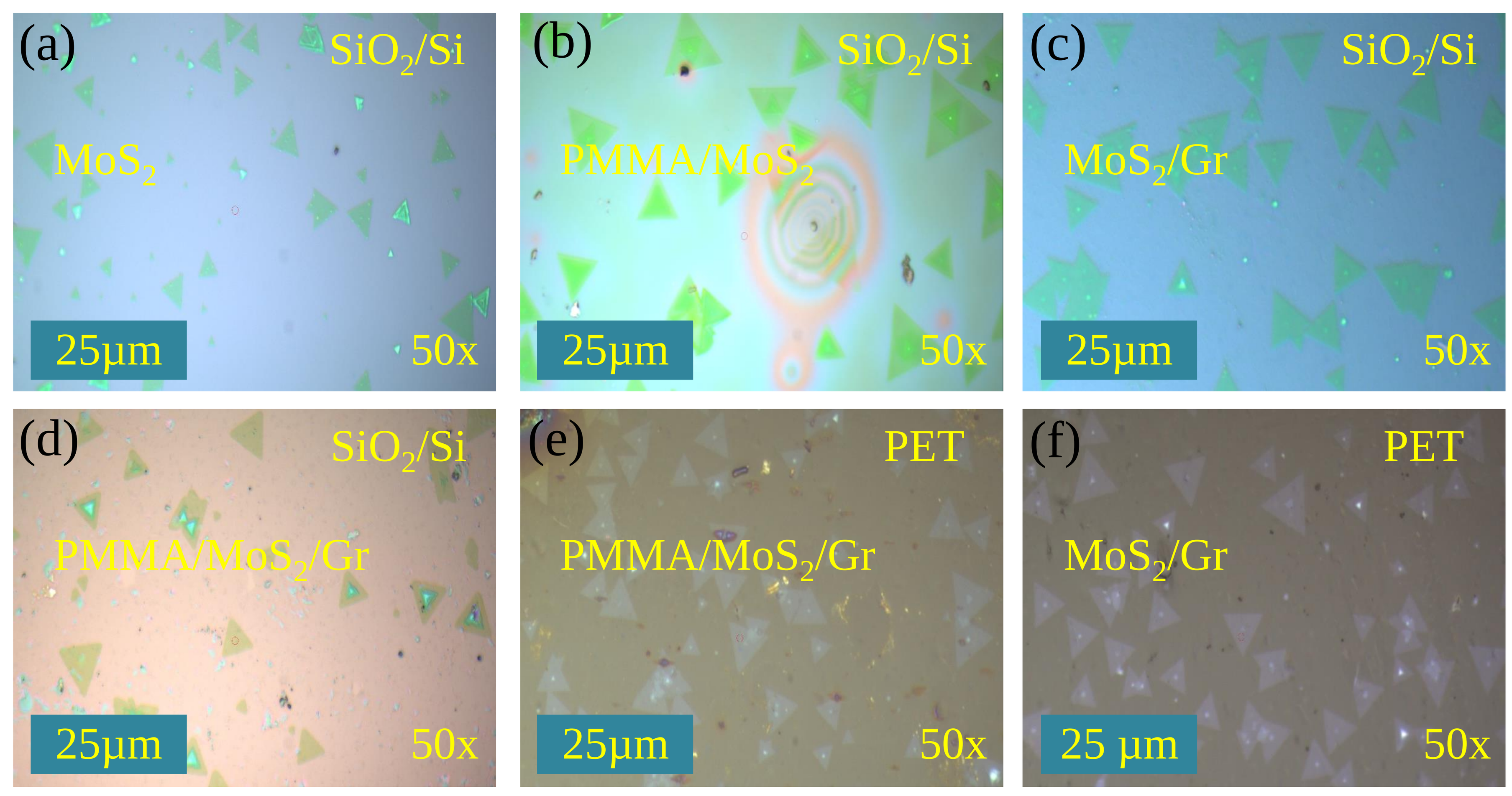
The most typical member in the two-dimensional (2D) transition metal dichalcogenides (TMDCs) family, layer-dependent molybdenum disulfide (MoS_2) with a particular direct band gap in monolayer has been widely applied in various sensors with high sensitivity. The huge research interest in MoS_2 is caused by its properties similar to graphene, the appearance of which turned the whole world of electronics. However, it is still challenging to achieve a large-area MoS_2 monolayer with desired material quality and electrical properties to fulfill the requirement for practical applications.

The growth of a high-quality defect-free monolayer depends on many factors, such as the type of substrate, quality of starting precursors, pressure, temperature, gas flow, etc. MoS_2 monolayer was prepared by chemical vapor deposition (CVD). The transfer of single layer MoS_2 to graphene to form a heterojunction, which has high sensitivity and excellent thermal stability due to synergistic effects, is of great significance for the development of MoS_2/graphene flexible wearable sensors.

PREPARATION



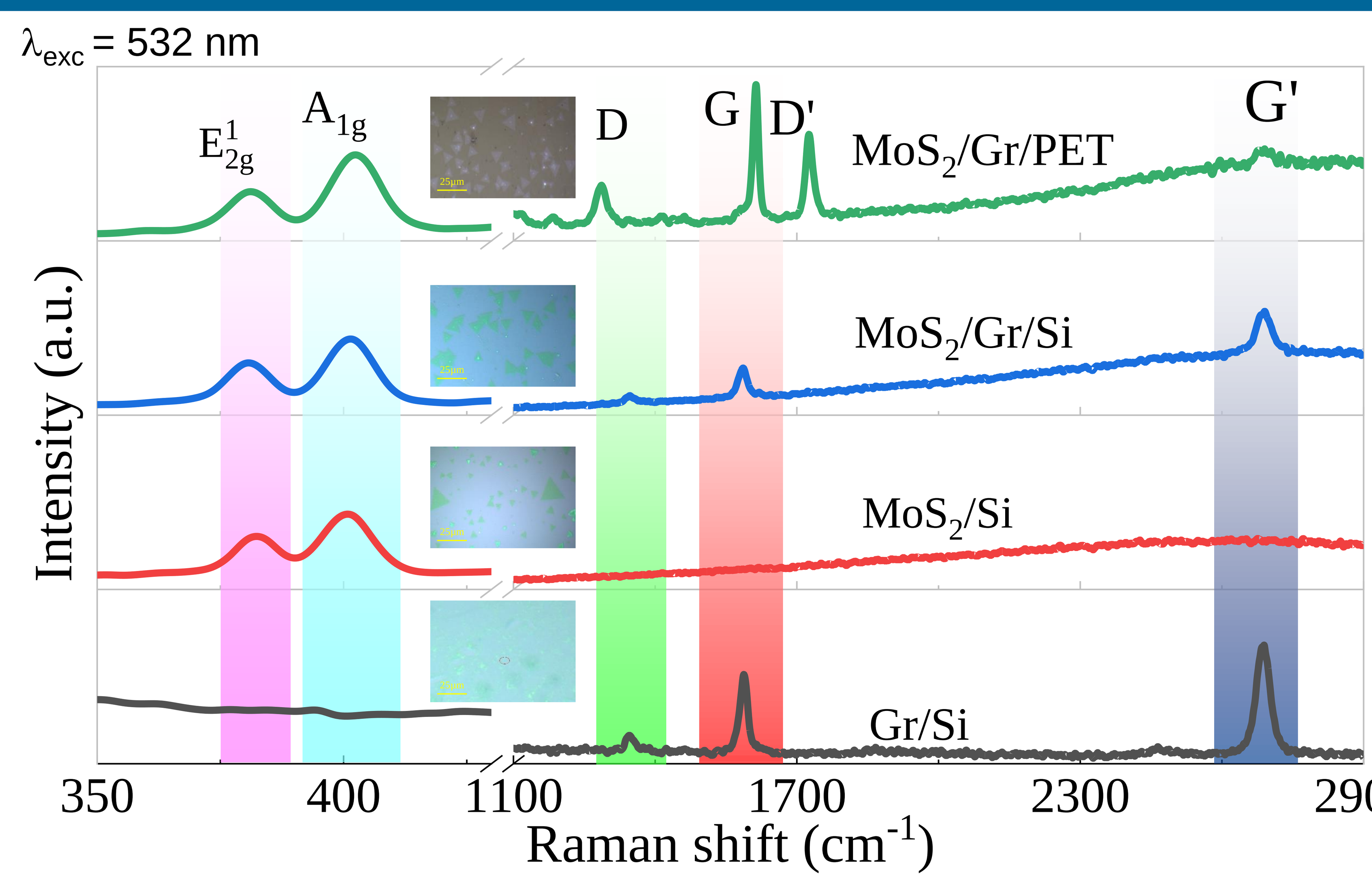
MORPHOLOGY



High-quality two-dimensional semiconductors were prepared by chemical vapor deposition (CVD). Optical surface morphology of MoS_2 on Si/SiO_2 (a). MoS_2/Gr is prepared by PMMA transfer and transferred to a flexible substrate (b-f).

RESULTS AND DISCUSSION

In this investigation, MoS_2 flakes prepared by CVD method were transferred from Si/SiO_2 to silicon-based ink for the creation of single-layer MoS_2/Gr laminated devices. The surface of MoS_2 is coated with polymethyl methacrylate (PMMA) and the SiO_2 layer is etched with sodium hydroxide. After that, the prepared graphene/SiO_2/Si is slid under PMMA/MoS_2, scooped out of the liquid solution, placed in the air to dry, and then baked at a temperature of 100 ℃ to reduce the wrinkles caused by the transfer of molybdenum disulfide on the substrate and to increase the adhesion of molybdenum disulfide to graphene. Finally, the PMMA was removed by cleaning in acetone to obtain MoS_2/Gr laminated structure. The above steps were repeated, and the MoS_2/Gr on the flexible substrate was obtained by using PET as the substrate. At all stages of the transfer process, Raman spectroscopy was used to get information about the quality of the MoS_2/graphene structure.



Raman spectra of monolayer-MoS_2/graphene structures on different substrates and precursor ones, as well as their morphology images.

CONCLUSIONS

1. The mono- and few-layer of MoS_2 flakes (triangles and stars) were grown. Raman spectroscopy and atomic force microscopy made it possible to clarify the number of layers and their quality.
2. MoS_2 flakes were transferred to a flexible substrate to develop a flexible electronic device.
3. The growth of high-quality defect-free MoS2 monolayers remains open and will offer prospects for the implementation of flexible electronics.

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