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Synthesis and doping of two-dimensional materials by CVD - MoS2 and graphene

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ABSTRACT: In this work we evaluated the synthesis and characteristics of pure molybdenum disulfene (MoS2) and witth phosphorus doping at 5, 10 and 15% combined with graphene oxide (GO) and monolayer graphene deposited over silicon (Si) and copper (Cu) substrates using two different methods: microdrop and Chemical Vapour Deposition (CVD). The chemical and structural information of the samples were evaluated by Raman spectroscopy, Scanning Electron Microscopy (SEM), Kelvin Probe Force Microscopy (KPFM) and Energy Dispersion X-ray Spectroscopy (EDS).

Keywords: graphene oxide, molybdenum disulfide, sensors, eletrochemical detection.

INTRODUCTION

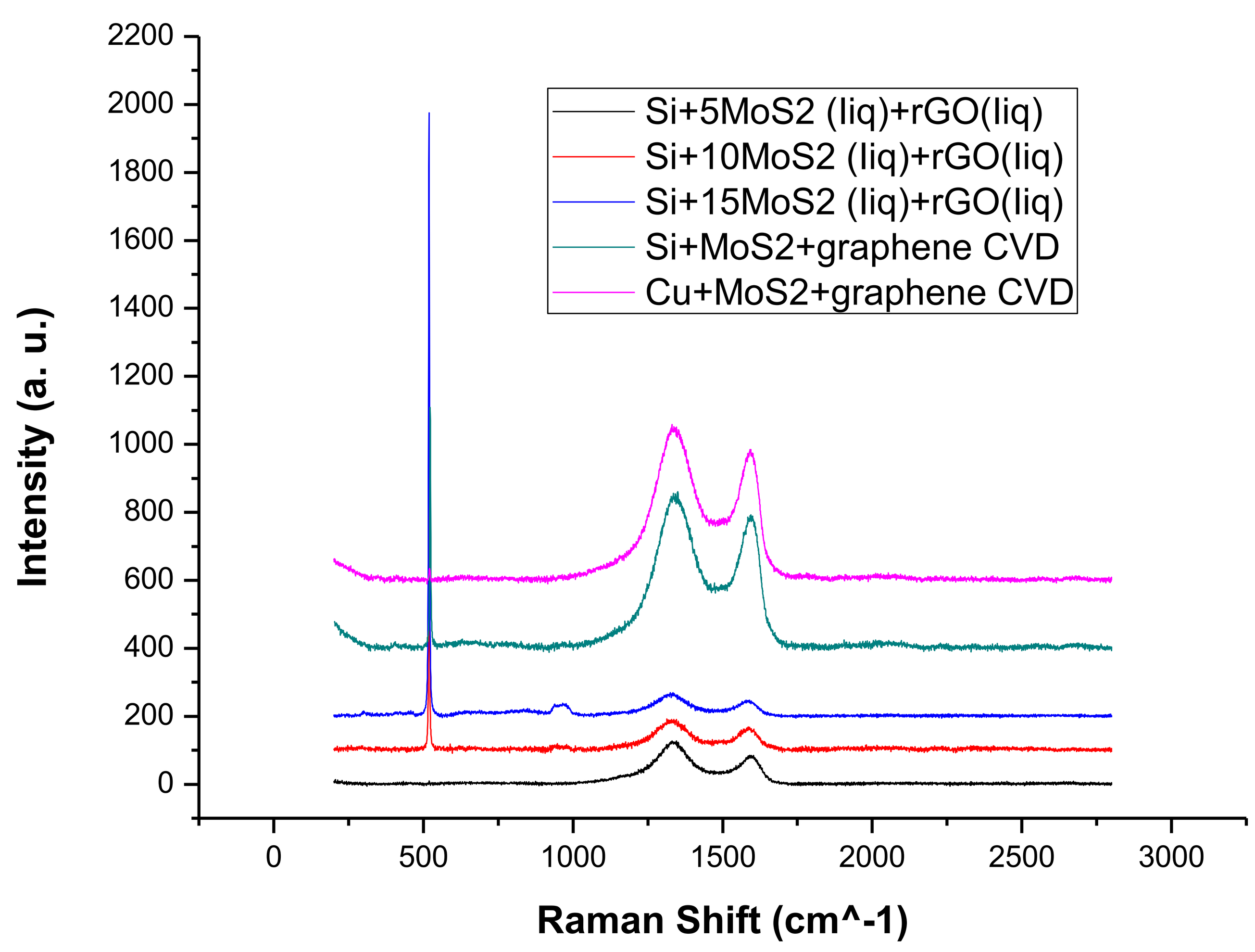
The combination of two highly versatile materials such as reduced graphene oxide (rGO) and MoS2 forms the layered rGO-MoS2 hybrids that have great potential for detection applications such as sensors. While graphene itself is chemically inert and a gapless semimetal, its isostructural analogue, MOS2 is chemically versatile with band gaps, thus finding significant use in a myriad of applications. Therefore, designing the structure and/or density of GBs in 2D materials could become a promising way to customize their performance.

METHODOLOGY

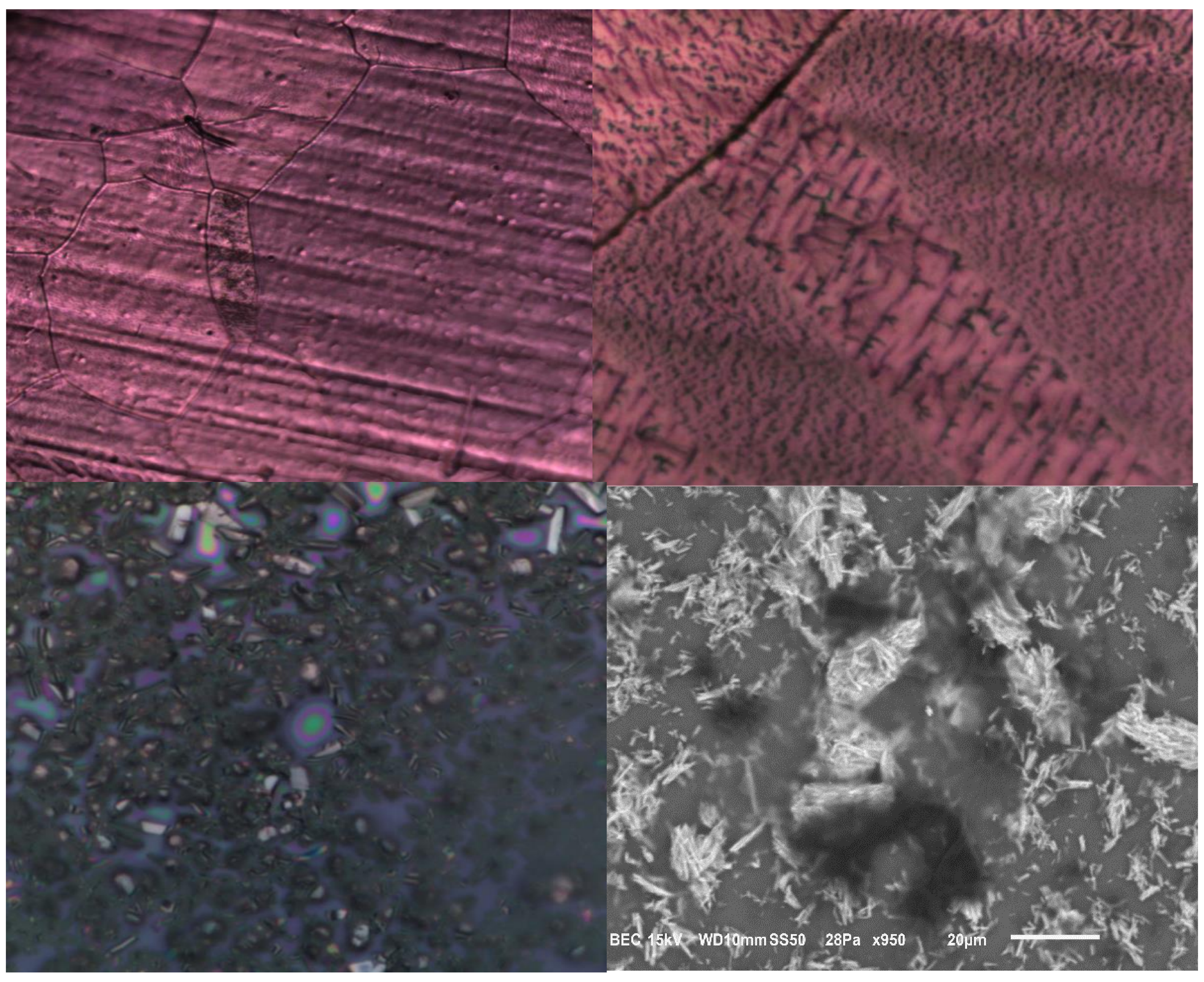
The depositions of materials by CVD and Drop Casting were performed using polished silicon and copper plates measuring 1 x 1 cm. The structural characterization of GO/MoS2 and graphene/MoS2 hybrids were evaluated by Raman Spectroscopy and Scanning Electron Microscopy (SEM) using a LabRAM HR Evolution equipment (Horiba) coupled to an AIST-NT microscope (Horiba), Kelvin Probe Force Microscopy (KPFM) using cantilever AC240 TMR3 (Asylum) with k=2 N/m and F=.70 kHz, and by Energy Dispersion X-ray spectroscopy (EDS) (Jeol EDS System).

RESULTS

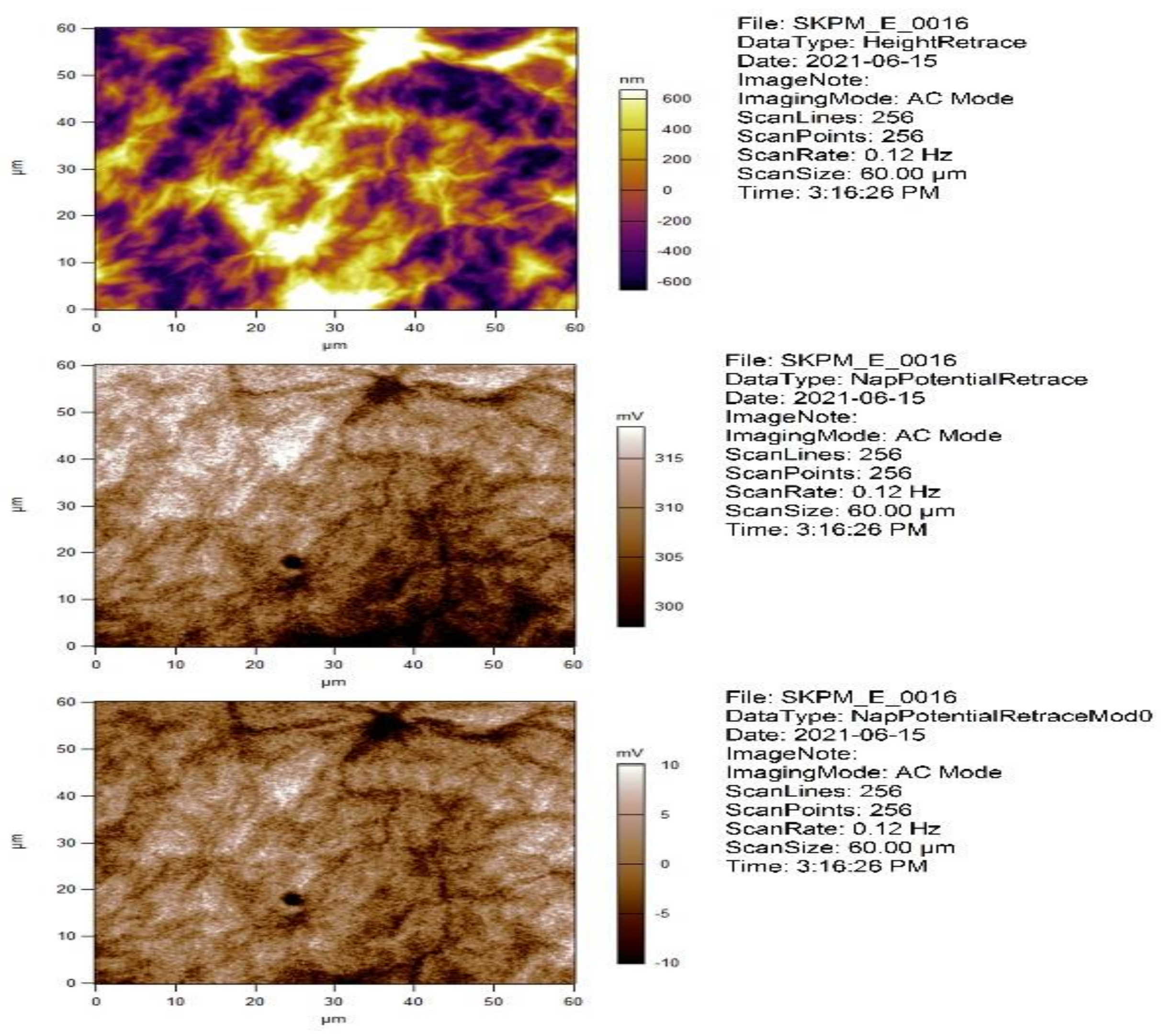
RAMAN Spectroscopy



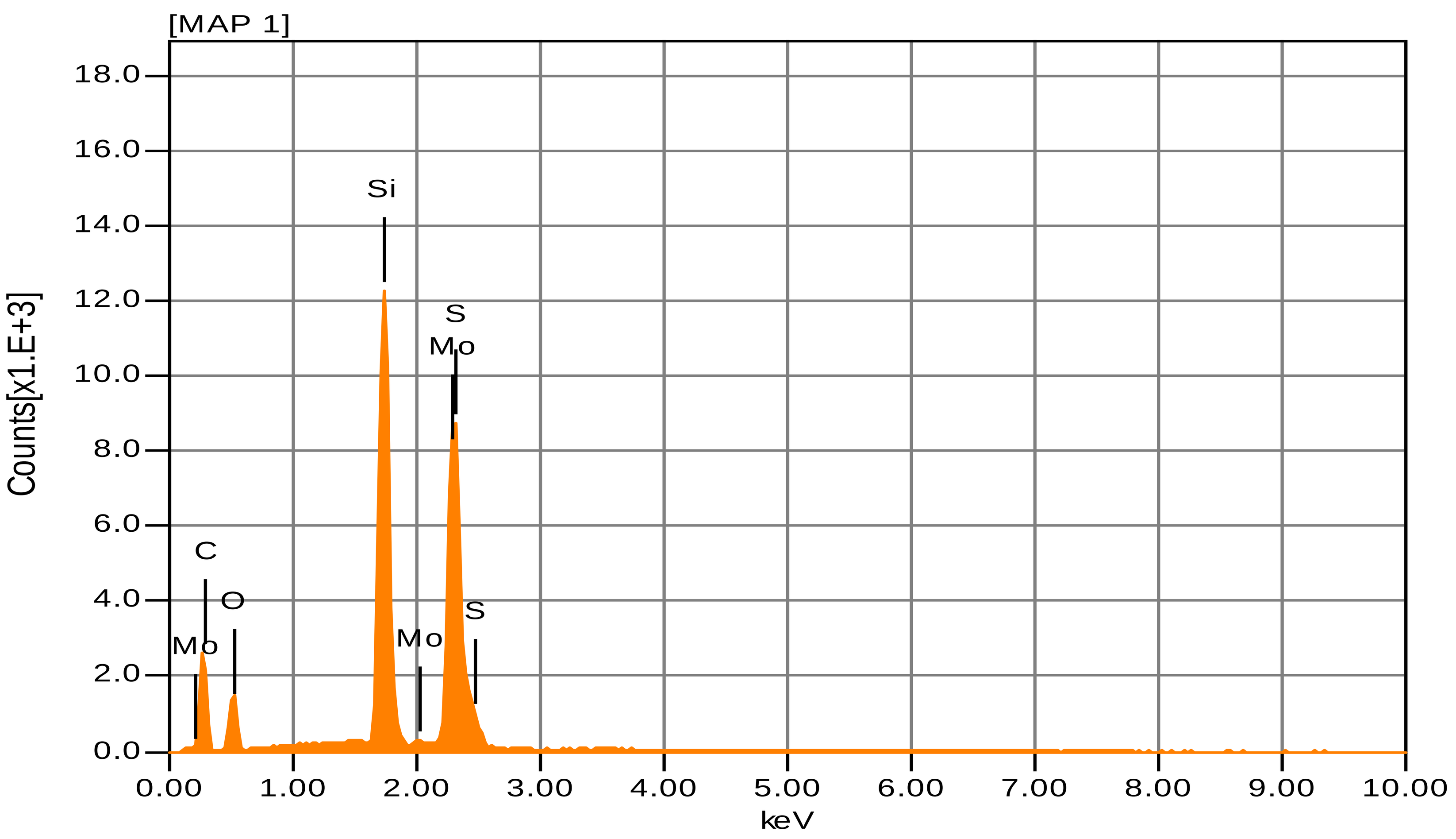
Scanning Electron Microscopy



Surface Potential Microscopy



X-ray Energy Dispersion Spectroscopy



CONCLUSIONS

Heterostructures of graphene/MoS2 were successfully deposited using both methods. The Raman spectrum revealed that the frequency of the peak located around 383 located at 407 cm-1, the plane mode corresponds to the sulfur atoms vibrating in one direction and the molybdenum atom in the other direction. Regarding graphene, the D-band was identified, this peak is due to the movement of the lattice away from the center of the Brillouin zone and its presence between 1270 and 1450 cm-1 (which depends on the excitation wavelength indicating defects or edges in the sample of deposited graphene. The morphological analysis by SEM revealed good formation in the contour of graphene grains and also positive growth of MoS2 crystals in the shapes of rods, flowers and pyramids. EDS spectroscopy showed the elemental atomic concentration (C 70.82%, O 18.25%, S 3.74%, Si 5.77%, Mo 1.41%) and the mass of the elements was in the order of C 54.53%, O 18.72%, S 7.69%, Si 10.39%, Mo 8.67%. number of deposited layers was from 1 to 10 and the band shift is characterized by an interfacial dipole at the Mos2/GO vertical junction. The surface photovoltage images reveal some surface defects and that the synergy of the materials is in the range between 300 and 375 mV. Lower Mobilities Fixed in GO/MoS2 and monolayer graphene/MoS2 based field effect transistors can originate from the defect limits and displacements in MoS2 films.