

Supplementary Information

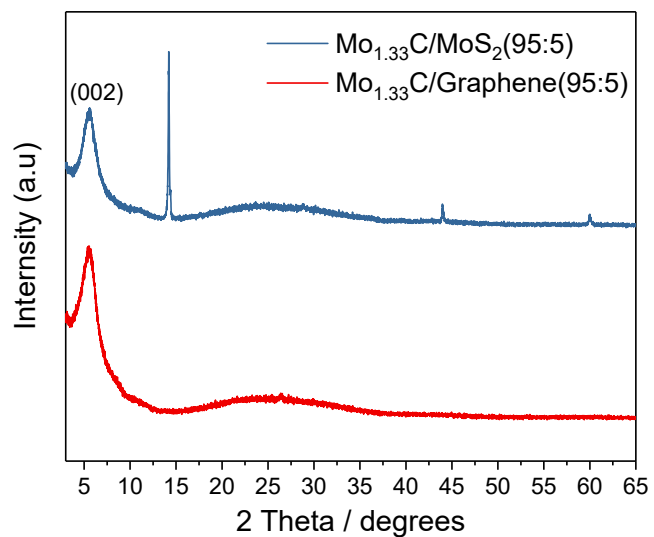


Fig. S1. XRD patterns of $\text{Mo}_{1.33}\text{C}$ *i*-MXene mixed with 5 wt. % graphene and 5 wt. % MoS_2 .

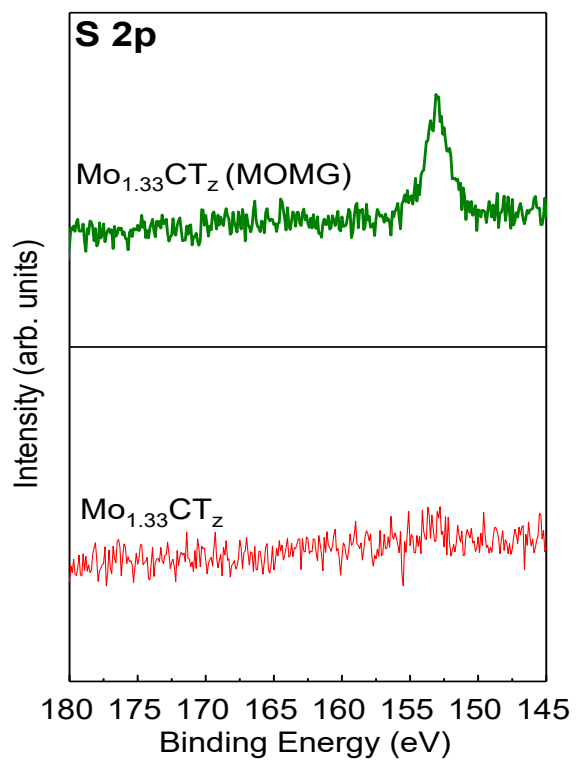


Fig. S2. The high-resolution S 2p XPS spectra of $\text{Mo}_{1.33}\text{C}$ and MOMG film.

Table S1. The relative content of Mo, S and C (at. %) from different regions of MOMG film, as shown in Figure 1e.

	Mo (at. %)	S (at. %)	C (at. %)
Mo _{1.33} C region	49.5	8.1	42.4
Graphene region	0.48	0.15	99.37
MoS ₂ region	41	29.25	28.96

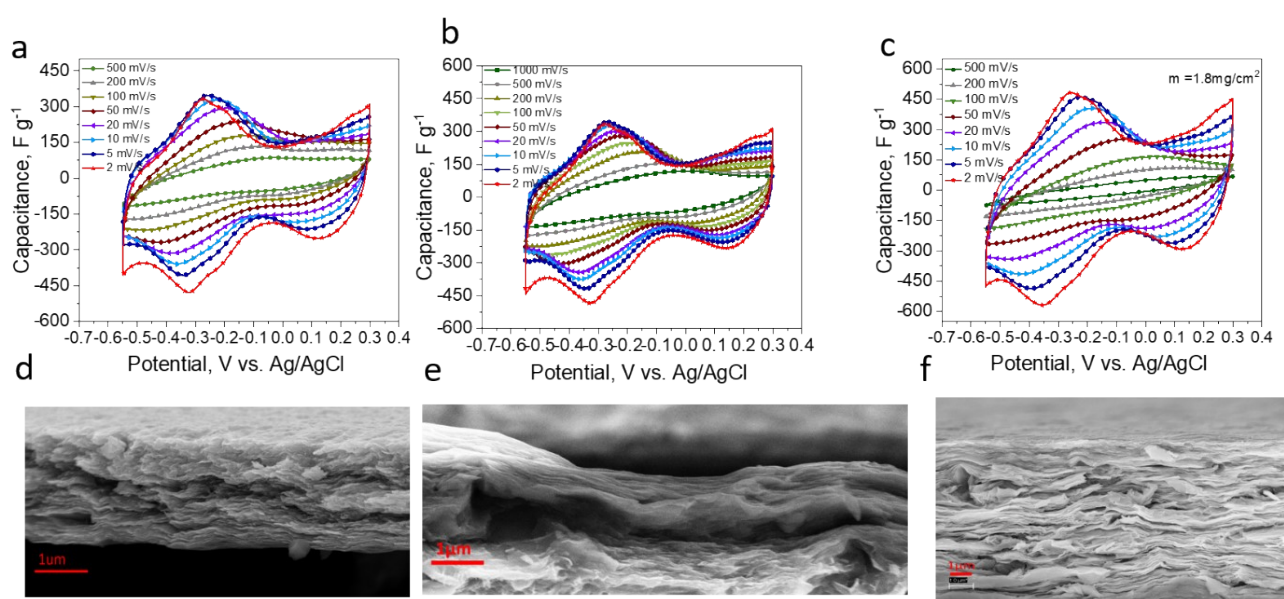


Fig. S3. CV curves and corresponding cross-sectional SEM images of (a, d) Mo_{1.33}C/MoS₂, (b, e) Mo_{1.33}C/Graphene and (c, f) MOMG films (8 μm).

To make sure that the MoS₂ and graphene used in this study are pure and exfoliated, set of surface and structure analysis techniques have been used to investigate the materials.

XPS of MoS₂ and Graphene

For the MoS₂, the Mo 3d level spectra were recorded from 222 eV to 240 eV and is shown in the Figure S4. In this case, one can clearly see that before and after the synthesis process, the contributions from the Mo⁴⁺ 3d_{5/2} and Mo⁴⁺ 3d_{3/2} were not affected indicating that material is not oxidized and also the crystalline phase 2H is not modified. This is something that need to be highlighted, since one could expect some oxidation, because the synthesis is done in an aqueous media; however, this result shows the excellent control during the process, avoiding the undesired oxidation. As expected, the signal for S 2s at ~226.2 eV is present. The minor contribution from Mo⁶⁺ 3d_{5/2} and Mo⁶⁺ 3d_{3/2} at ~233 eV and ~235.4 eV, respectively, is consistent with a minor oxidation but present from the initial sample without further modification.

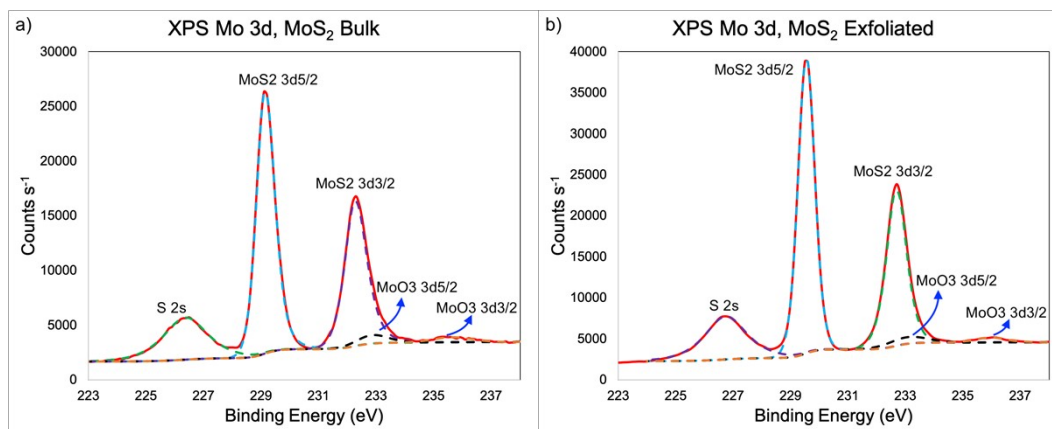


Fig. S4. High-resolution XPS spectra for the Mo 3d region of the a) MoS₂ starting material and b) MoS₂ after exfoliation.

To easily understand the changes during the different chemical modifications, the starting graphitic material is also included, the reader can recall from the synthesis that it was **graphite nanoparticles (GNPs)**. The C1s core level spectra are shown in Figure S5, where a) corresponds to GNPs and b) to the exfoliated **graphene (GEX)**. The signal coming from the GNPs is composed only by C-C, with a single contribution at 284.48 eV, the absence of any other signal, reveals purity and crystallinity of the material, proving at the same time information that no previous oxidation is present.

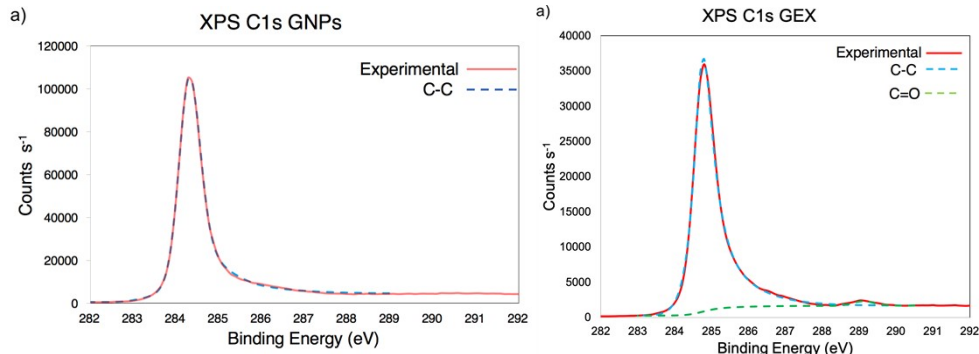


Fig. S5. High-resolution C 1s spectra of a) GNPs and b) Exfoliated Graphene (GEX)

As one can see, the spectra obtained is very similar to the starting GNPs, with just a small amount of carbonyl (<1%).

Raman spectroscopy of graphene-based materials

To compare the structural quality of the graphene-based materials, Raman spectra (Figure S6) recorded with 2.33 eV laser energy is presented. It is well known that the particular dispersion of π electrons in graphene offers powerful and efficient insights of their electronic properties and crystallinity. It can be noticed that all spectra exhibit an intense band from 1450-1660 cm^{-1} corresponding to the *G* band due to vibrational E_{2g} degenerative mode observed in sp^2 carbons. Furthermore, another band is observed at 1260-1400 cm^{-1} , assigned to the *D* band and related to the A_{1g} mode. The *D* peak is originated due to the interaction between phonons and defects, such as in-plane substitution heteroatoms, vacancies, or grain boundaries.

For better clarity, the section between 1200 to 1700 cm^{-1} is presented in the Figure S6. In this regard, previous studies used *D* peak to quantify the number of defects in graphene by means of the intensity (peak integrated area) ratio of *D* and *G* peaks (I_D/I_G).

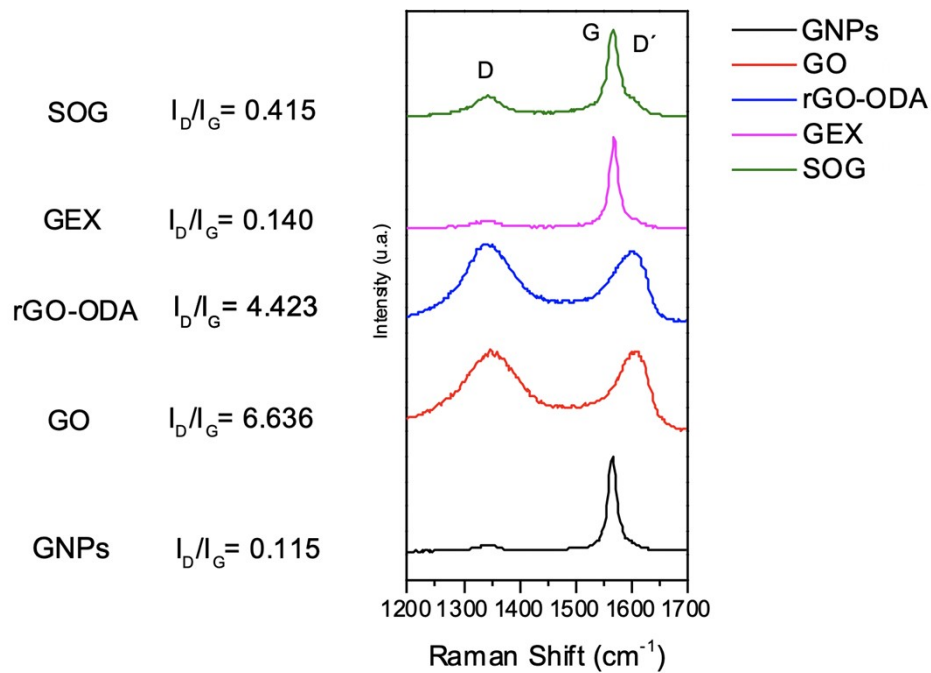


Fig. S6. The Raman spectra of graphene-based materials.

As expected, the material with the best crystallinity are the starting GNPs, with an I_D/I_G value of 0.115, since they were not subjected to any process. These results indicate that Exfoliated Graphene exhibit crystallinity that is more related to graphene grown by CVD rather than GO or rGO, which is excellent taking into account the simplicity of the method and its scalability.

The Exfoliated Graphene is presented in Figure S7 showed a lateral dimension of ~ 600 nm. On the other side the MoS₂ layered structure that has lateral size around 300 nm.

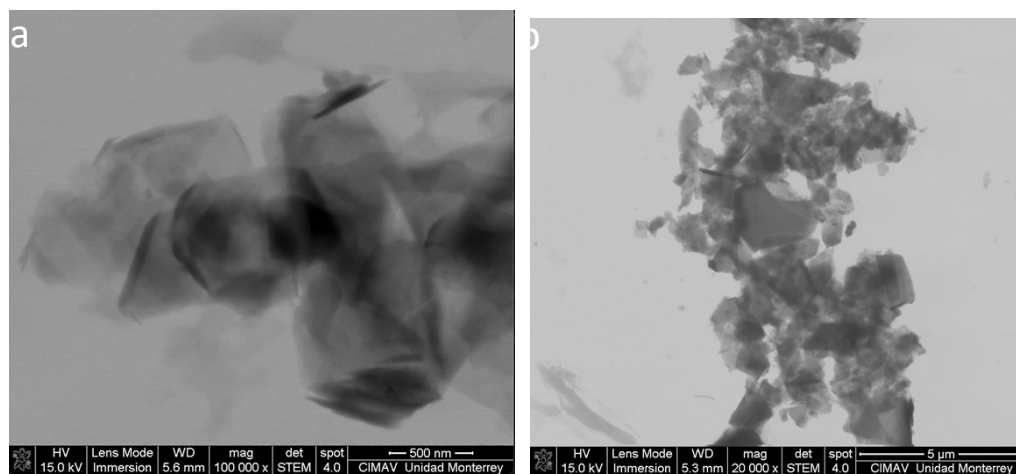


Fig. S7. ABF STEM micrographs of a) Exfoliated Graphene (GEX) and b) MoS₂.