Synthesis, structural characterization and electronic properties of V_2CT_x MXene nanosheets

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A new family of 2D materials has emerged, consisting of transition metal carbides, nitrides, and carbonitrides, also known as MXenes. The vast majority of MXenes known to date have been produced by selectively etching Al from Al-containing MAX phases.[1] During the etching process, the MXene surface acquires terminating functional groups, which is why they are commonly designated as $M_{n+1}X_nT_x$, where T_x represents surface terminating groups such as -O, -OH, and/or –F, as shown in Fig1(a).[2-3]

Herein, two-dimensional V_2CT_x nanosheets were obtained by chemical exfoliation of as-grown V_2AlC single crystals [4] in 40% HF solution at room temperature. The influence of etching time on the synthesis and structural evolution were studied. The paper-like structure of as-prepared V_2CT_x nanosheets was confirmed by SEM and micro-Raman,as shown in Fig1(b,c).

Following a mechanical exfoliation, thin V_2CT_x flakes have been successfully transferred on Si/SiO_2 substrates. In order to measure electrical transport of as-transferred V_2CT_x flake, e-beam lithography techniques were applied to pattern electrical contacts on top of the flakes, as shown in Fig1(d). Electrical properties of V_2CT_x flakes were obtained for a range of temperature between 4K and 300K temperature range were tested. Individual V_2CT_x flakes exhibits metallic behavior. Magnetotransport down to low temperature allows to extract intrinsic charge carrier properties, which are compared with bulk MXene and MAX phases values. DFT calculation were performed and compared with the experimental results.

References

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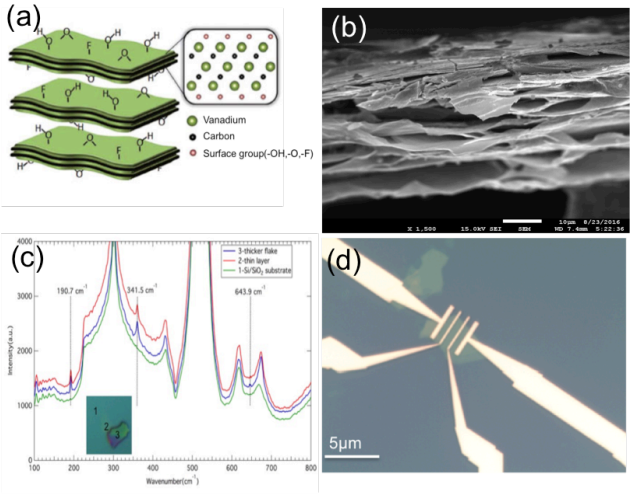

Figures

Figure 1: (a) Structure of terminated V_2CT_x MXenes (b)SEM image of V_2AlC after etching 96h, showing the highly delaminated paper-like layered structure V_2CTx ; (c) Raman spectra of V_2CT_x nanosheets on the Si/SiO_2 substrates;(4) Electrical contact pattern of V_2CT_x nano device