Solvothermal synthesis of 2D titanium carbo-oxide: High selective gas-sensing and supercapacitor evaluations

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Abstract

Owing to the ever-increasing world population, energy shortage and environmental pollution issues have become hot topics. Therefore, research for innovative new materials to sort out such issues are urgent [1]. Among the known conventional nanostructured materials, two-dimensional (2D) nanomaterials have attracted increased interest due to their outstanding electrical, magnetic, and mechanical properties; make them highly suitable for supercapacitor (energy storage) and gas sensor (environmental monitoring) applications[2,3]. However, the commonly synthesis method of some of these 2D material such as MXene are not simple and involves the etching step of MAX phase via highly concentrated hydrofluoric acid, which, in addition to be highly toxic, generally leads to a high content of -F termination groups on the surface of the material, thus negatively affecting its performances. In this work, we are developing for the first time, to the best of our knowledge, a highly pure new 2D titanium carbo-oxide layered structure, via simple and eco-friendly solvothermal method using MAX phase and tetramethylammonium hydroxide (Figure 1). The full characterizations using XRD, Raman, SEM, HRTEM and XPS confirm the formation of the crystalline 2D titanium carbo-oxide layered structure. The prepared new 2D nanomaterial (which is not MXene usually obtained from MAX Phase) has a very good selective methanol vapor sensing properties at room temperature, which may be useful for environmental monitoring as well as for the non-invasive assessment of gut bacterial activity by measuring methanol in exhaled breath. The evaluation of its supercapacitor in three different basic (KOH), neutral (Na_2SO_4) and acidic (H_2SO_4) electrolytes demonstrates that KOH is the most effective solution to obtain high electrochemical performance. This material is very promising to be applied for some other high-tech applications.

References

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Figures

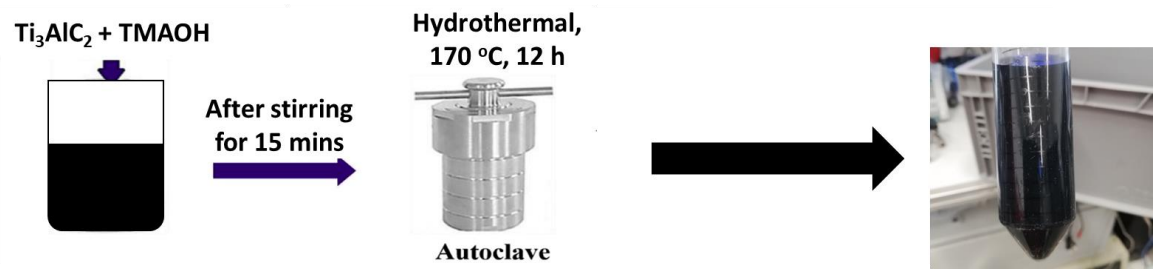

Figure 1: Synthesis route