Ti_3C_2 MXene 2D MATERIALS AND THEIR APPLICATIONS

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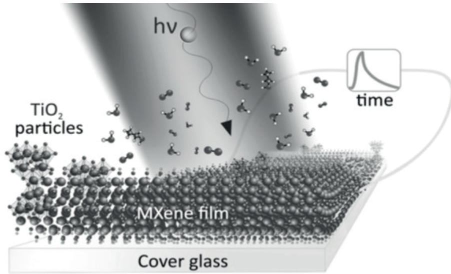
The success in 2D exfoliation or graphene synthesis inspired the Drexel University team to use multicomponent and multilayer materials, such as MAX phases [1]. Thus, in 2011, the first publication [1] appeared with a report on successfully synthesizing of $Ti_3C_2T_x$ MXene from Ti_3AlC_2 MAX phase ceramics. Currently, there are many publications, and we can find different areas where we can use 2D MXene materials. There are optical and chemical sensors, catalysts, nonlinear optical attenuators [2], electrodes for supercapacitors, and optoelectronic devices [3].



MXene has terminated functional groups. There are differences due to the method of synthesis. Water-based synthesis leads to –OH, –F, or =O formation on the top of MXene flakes after Al etching. Due to –OH termination, MXene flakes are hydrophilic. It is worth noting that graphene flakes are hydrophobic, and this can be a big problem in applications for batteries or supercapacitors using water-based electrolytes. Due to their small thickness and metallic behavior, MXene flakes have a localized surface plasmon resonance. Effectively utilizing localized surface plasmon resonance can be used for atoms or molecules grafting as functional groups on MXene flakes. Therefore, this is a fascinating material where we can change functional groups (electron donor, electron acceptor, hydrophilic or hydrophobic surface) to adjust/tune the work function energy level in the application of electronic devices.

The self-oxidation of MXene flakes leads to TiO_x formation at the edge of flakes or on the crystalline defects of MXene. As a result, we can use a combination of semiconductive TiO_x quantum dots and conductive Ti_3C_2 MXene flakes. These materials started to be used as electrodes in supercapacitors with pseudocapacitance, batteries, and in gas sensors.

In my talk, I will give the information about MXene synthesis from the MAX phase, and I will try briefly to show the area for MXene application.

References:

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