MXENE: Blocking Electromagnetic Radiation

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Abstract* - *The radiations emitted from Television, Mobile Phones, Microwave ovens and several other devices results in inevitable damage in one form or more. From acute interference in signals to damage to health, the damage persists. A material, MXene is found to resolve this issue. MXene is a composition of Titanium and carbon, is malleable, and these sheets are in the thickness of just one nanometer. The discovery comes from South Korea's Korea Institute of Technology in Seoul who are working on Drexel University in the US. In this Journal, the preparation, properties, theoritical and practical applications and emphasis on possible utilities of MXene in blocking electromagnetic radiation from devices using Electromagnetic Interference Shielding.

Keywords: MXene, Bioelectromagnetics, Graphene, 2D, REM,

I. INTRODUCTION

With advancement in technology, come inevitable harm in levels small and large. Eliminating the harm completely is by par impossible rather reducing or blocking these factors at a very basic level cuts it to a very infinitesimally small factor which is often negligible.

Radiation is one of the lethal issue that the environment deals with every minute of everyday, ever increasing in magnitude and refusing to cease. Radiation occurs when the atomic nucleus of an unstable atom decays and it starts releasing ionizing particles which are called ionizing radiation. When these particles come into contact with organic material, for instance the human tissue, they mutilate them if levels are high enough, spawning medical conditions such as burns and cancer. Ionizing radiation can be fatal for humans and the environment in general. A unit is defined to measure the Radiation Dosage; Roentgen Equivalent in Man (REM).The measurement is used to determine the levels of radiation, if they are safe or dangerous for human tissue. It is the product of the absorbed dose in rads and weighting factor (represented as W_R), which accounts for how effective the radiation is in causing biological damage.A sudden, short dose of upto 50 rem will cause no problems, except for some blood changes. From 50 to 200 rem there may be illness, but fatalities are highly unlikely. A dose of between 200 and 1,000 will most likely cause serious illness: the nearer the 1,000 it is, the poorer the outlook for the human will be. Any dose over 1,000 will typically cause death. MXene is has exceptional properties, as an analogy, the conductivity of MXenes is comparable to that of multi-layered graphene. Density functional theory (DFT) computations have shown that MXene is quite stiff, with in plane elastic constants exceeding 500 GPa. Mxene is found to block the radiations emitted right from the atomic level.

II. SYSTEM MODEL

Properties of MXene:

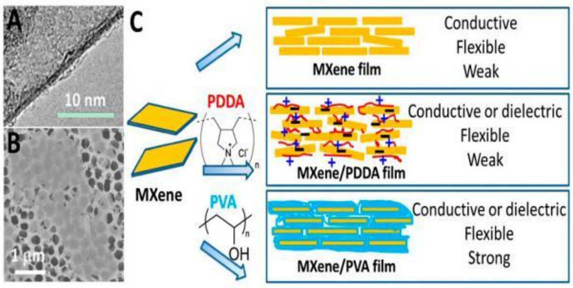


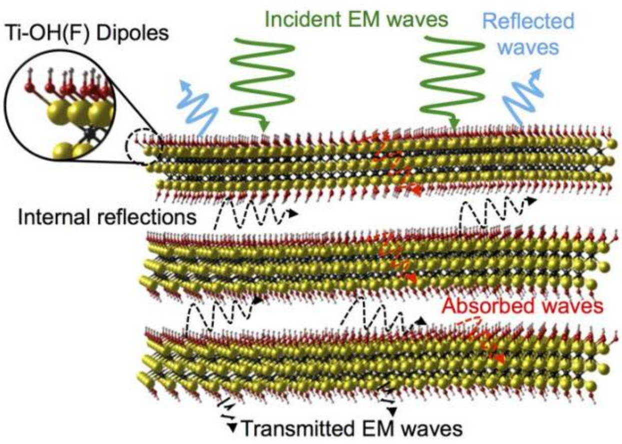
Figure 1

(A) TEM and (B) SEM images of MXene flakes after delamination and before film manufacturing. (C) A schematic illustration of MXene-based functional films with adjustable properties. on the fabrication of conductive, flexible free-standing MXene films and polymer composite films that possess excellent flexibility, impressive electrical conductivity, and hydrophilic surfaces. In this study, Ti3AlC2 was chosen as the MAX precursor because its exfoliation and delamination have already been well developed (7, 12, 14, 33). Two polymers chosen: poly(diallyldimethylammonium chlo- ride) (PDDA) and polyvinyl alcohol (PVA). The former was chosen because it is a cationic polymer and the Ti3C2Tx flakes are negatively charged. The PVA was chosen for several reasons, which include its solubility in water, the large concentration of hydroxyl groups along its backbone, and its extensive utilization in gel electrolytes and composites(23, 26, 34, 35). Both Ti3C2Tx /PDDA and Ti3C2Tx /PVA composite films were fabricated and characterized. A sketch explaining the route for fabricating MXene based films and their resulting properties is shown in Figure 1.

Electromagnetic Interference Shielding with 2D Transition Metal Carbides known as MXenes is a method used to contain the electromagnetic radiations that cause harm to life and the support system. Electromagnetic shielding is the process of minimizing the electromagnetic field in any given space by blocking the field with barriers

made of conductive as well as magnetic materials. Shielding is employed to enclosures to isolate electrical devices from the 'external environment', as well as to cables to isolate wires from the environment through which the cable runs. Electromagnetic shielding that blocks radio frequency electromagnetic radiation is also known as RF shielding.

The shielding can diminish the coupling of radio waves, electromagnetic fields and electrostatic fields. A conductive enclosure used to block electrostatic fields is known as a Faraday cage. The amount of reduction depends relatively on the type of material used, its thickness, the size of the shielded volume and the frequency of the fields of interest and the size, shape and orientation of apertures in a shield to an incident electromagnetic field.

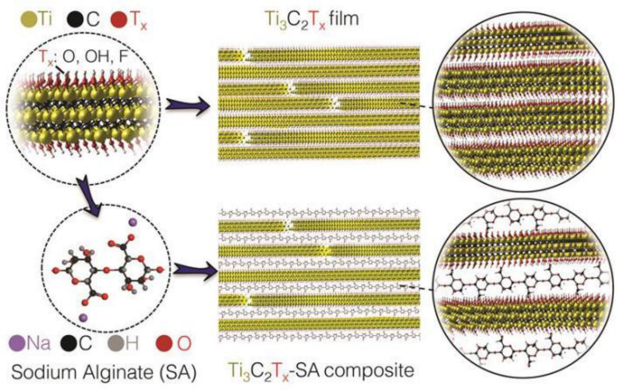


MXene is found to parish off electromagnetic interference by two methods- 1.absorbing and 2.trapping the radiation between its layers. MXene can be used as a spray coating when combined with polymer solution to protect components from electromagnetic interference.

The crucial vein to MXene's performance is credited to its high electrical conductivity and 2D structure. According to the authors, when electromagnetic waves come in contact with MXene, some are immediately reflected from its surface, whereas others pass through the

surface however they lose energy amidst the material's atomically thin layers. The lower energy electromagnetic

waves are eventually reflected back & forth off the internal layers until they're completely absorbed in the structure. The MXene flakes are embedded in sodium alginate to make ultra-thin, corrosion resistant films that are used as shielding composites. This when compared with metal foils proves to be very efficient and easier to process.



III. PREVIOUS WORK

So far, electromagnetic shielding materials used add a substantial amount of weight and volume to mobile devices. This could be eliminated by using a thin coating of MXene to protect individual components. Researchers working on MXene in Drexel's Department of Materials Science and Engineering tested samples of MXene films ranging in thickness from just a couple micrometers (one-thousandth of a millimeter) up to 45 micrometers, which is marginally thinner than a human hair. This is significant because a material's shielding effectiveness, a measure of a material's ability to block electromagnetic radiation from passing through it, tends to increase with its thickness, and for purposes of this research the team was trying to identify the thinnest iteration of a shielding material that could still effectively block the radiation.They noted that the thinnest film of MXene is competing with copper and aluminum foils when it comes to shielding effectiveness. And by increasing thickness of the MXene to 8 micrometers, they could achieve 99.9999 percent blockage of radiation with frequencies covering the range from cell phones to radars. When compared to other synthetic materials, such as graphene or carbon fibers, the thin sample of MXene performed much better. In reality, to achieve commercial electromagnetic shielding requirements, currently used carbon-polymer composites would have to be more than one millimeter thick, which would add quite a bit of heft to a device like an iPhone, that is just seven millimeters thick. Thus, the previous applications of electromagnetic shielding could be leveraged and surpassed with regards to MXene in blocking radiation from devices such as mobiles and ovens.

III. PROPOSED SYSTEM

The ever expanding electrical energy storage market requires new devices to power everything, from electronics to electric cars. Electrochemical capacitors, are conjectured to become a $5B market according to the

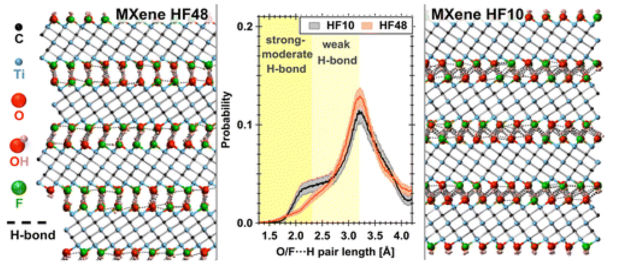
IDTechEx forecast, use activated carbon to store charge by adsorption of ions in pores. Introduction of new materials with high electrical conductivity and high specific surface is needed to further enhance capacitance of devices. The two-dimensional carbides and nitrides (MXenes, where M stands for an early transition metal and X stands for carbon or nitrogen) with every crystal having the thickness of just about 1 nanometer (approximately 50,000 times thinner than a human hair) has just been reported in Advanced Energy Materials.Ti3C2 MXene shows a very high capacitance in aqueous salt solutions, having a low accessible surface area. The researchers explains this paradox by cationic insertion between atomically thin MXene layers, accompanied by significant deformation of the MXene particles that occurs so rapidly so as to resemble two-dimensional ion adsorption at solid-electrolyte interfaces in activated carbon or graphene. Li, Na, K, Cs, Mg, Ca, Ba, and organic cations can be reversible inserted between MXene layers. By using a new in situ quartz-crystal microbalance technique with dissipation monitoring the authors found and quantified the phenomenon of potential-dependent deformational waves in MXene caused by insertion of ions during charging/discharging. Metaphorically, MXene electrodes "breathe" when charged and discharged allowing even fairly large ions to penetrate between the layers and store an increased amount of charge. It's thermal stability goes upto 800 degree Celsius in Ar atmosphere.

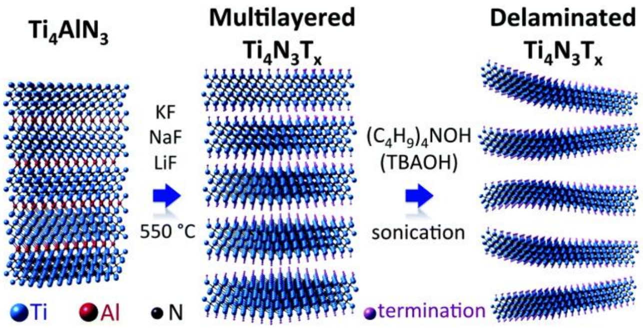
PROPOSED SYSTEM FEATURES:

- Deciphering the MXene capacitive paradox
- Studying its properties vs traditional methods
- Deformation waves in MXene

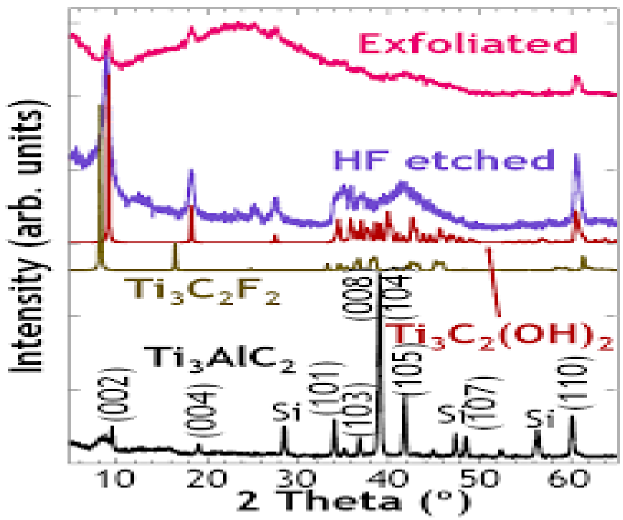
IV. SIMULATION

A complex surface chemistry and small coherence length have been obstacles in some applications of MXenes, also limiting the accuracy of predictions of their properties. The modeling approach leads to new understanding of MXene structural properties and can replace the currently used idealized models in predictions of a variety of physical, chemical, and functional properties of Ti3C2-based MXenes.





The developed models can be employed to guide the design of new MXene materials with selected surface termination and controlled contact angle, catalytic, optical, electrochemical, and other properties. We suggest that the multilevel structural modeling should form the basis for a generalized methodology on modeling diffraction and pair distribution function data for 2D and layered materials.



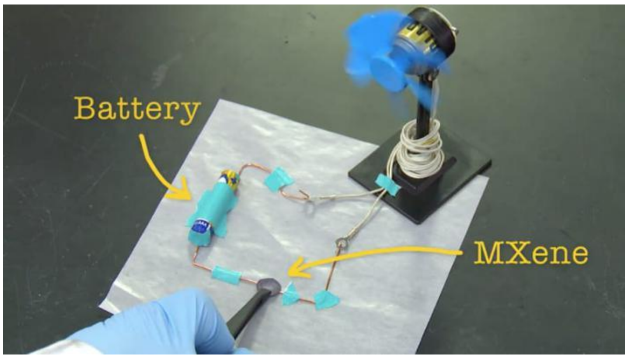
The Drexel team has been diligently examining MXenes like a paleontologist carefully brushing away sediment to unearth a scientific treasure. Since inventing the layered carbide material in 2011 the engineers are finding ways to take advantage of its chemical and physical makeup to create conductive materials with a variety of other useful properties. One of the most successful ways they've developed to help MXenes express their array of abilities is a process, called intercalation, which involves adding various chemical compounds in a liquid form. This allows the molecules to settle between the layers of the MXene and, in doing so, alter its physical and chemical properties. Some of the first, and most impressive of their findings, showed that MXenes have a great potential for energy storage.

V. CONCLUSION

Though just a few atoms thick, the MXene-polymer nanocomposite material shows exceptional strength - especially when rolled into a tube.The testing also revealed hydrophilic properties of the nanocomposite, which means that it could have uses in water treatment systems, such as membrane for water purification or desalinization, because it remains stable in water without

breaking up or dissolving.In addition, because the material is extremely flexible, it can be rolled into a tube, which early tests have indicated only serves to increase its mechanical strength. These characteristics mark the trail heads of a variety of paths for research on this nanocomposite material for applications from flexible armor to aerospace components. The next step for the group will be to examine how varying ratios of MXene and polymer will affect the properties of the resulting nanocomposite and also exploring other MXenes and stronger and tougher polymers for structural applications. Not only is MXene looked at from the perspective of blocking electromagnetic radiation but also, the capacitive and properties it carries.

VI. FUTURE SCOPE



Researchers at Drexel University have hit upon a conductive clay which they claim is an "exceptionally viable candidate" to one day replace the electrode materials used in batteries and supercapacitors. Sure, another day another super material, but MXene, as it's called, does boast some rather intriguing properties.

It's three crucial properties, which are namely, it's hydrophilic nature, is malleable and loses no capacitance even after 1000 charge cycles. All the properties together make MXene suitable for acting as a shield against electromagnetic radiation for devices, owing to its plethora of advantages and efficiencies. This journal is to shed light on the future prospects MXene holds, and its revolutionary effects when the applications of the same are deployed for curbing with the inevitable damage radiation causes to life.

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