Two-dimensional (2D) solids – the thinnest materials available to us – offer unique properties and a potential path to device miniaturization. The most famous example is graphene, which is an atomically thin layer of carbon atoms. Recently, an entirely new family of 2D solids – transition metal carbides (V$_2$C, Ti$_3$C$_2$, Nb$_4$C$_3$, etc.), nitrides (e.g., Ti$_4$N$_3$) and carbonitrides (e.g., Ti$_3$CN) named “MXenes” – was discovered by Drexel University scientists [1-3]. About 20 different carbides and carbonitrides have been synthesized to date [3-7] and dozens more predicted by the density functional theory (DFT), promising to make MXenes the largest known family of 2D materials. MXenes can be metallic or semiconducting, depending on their composition and surface termination. Their elastic constants along the basal plane are predicted to be higher than those of the binary carbides. Oxygen- or OH- terminated MXenes are hydrophilic and can be dispersed in water. Polar organic molecules and cations ranging from Na$^+$ to Mg$^{2+}$ and Al$^{3+}$ intercalate MXenes [4]. Stable colloidal solutions of single- and few-layer flakes have been produced and used to manufacture thin transparent films with high electrical conductivities. One of the many potential applications for 2D carbides is in electrical energy storage devices, such as batteries, Li-ion or Na-ion capacitors and supercapacitors [3-6], but sensors, sorbents, ion separation membranes and other applications are also being explored. Ti$_3$C$_2$ paper electrodes show a higher Li-ion capacity than graphite anodes and can be charged/discharged at significantly higher rates. They also demonstrate a very high intercalation capacitance (up to 1000 F/cm$^3$) in aqueous electrolytes [5-6]. Most importantly, unprecedented control of properties can be achieved in this new system, opening new horizons for design of materials with the required set of properties.

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