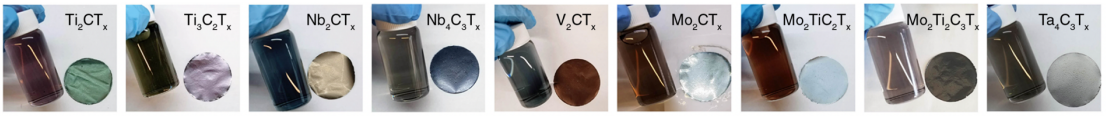
Lunar New Year: Advancing the Ancient Art of Calligraphy

It is said that writing calligraphy at the beginning of the year brings good luck and peace and sets the tone for the entire year to come. Chinese calligraphy has been a popular art form for centuries, particularly during the Spring Festival, or Lunar New Year. The characters used often symbolize wishes for health, wealth, and prosperity. The most common character written is '福', which symbolizes happiness and good fortune. Calligraphers use their unique style to inscribe these symbols on red paper to create beautiful works of art. People often hang these calligraphy artworks on the wall of their homes and businesses to usher in a prosperous year.

Calligraphy ink is an important component of this ancient art form and was often made from a combination of pigments and binding agents, including lampblack, glue, and water, that are designed to dry quickly and to easily manipulate. Binders and glues are used for calligraphy ink because they help the ink to adhere to the paper and prevent bleeding/fuzzy edges, making the ink manageable to be shaped into beautiful letters and designs. MXenes, a large family of two-dimensional (2D) materials discovered at Drexel University in 2011, are elevating this tradition to the 21st century, offering the potential to revolutionize calligraphy ink materials as a non-bleed ink, and inherently providing other enhanced qualities as well.



MXene solutions and their dry films show a variety of plasmonic colors, depending on the composition and structure of MXenes. The color can be controlled by controlling the arrangement of atoms in MXene.

Bleeding makes writing with diluted ink difficult, limiting the lightest shade of color that can be created with these inks, and thus the shade contrasts that are highly praised in Chinese painting. Traditionally, the bleeding of diluted calligraphy ink must be carefully managed by the type of paper used, and the pressure applied when writing. MXene ink, regardless of the concentration, paper type, or pressure, always delivers the characters and designs intended with clear, sharp edges.

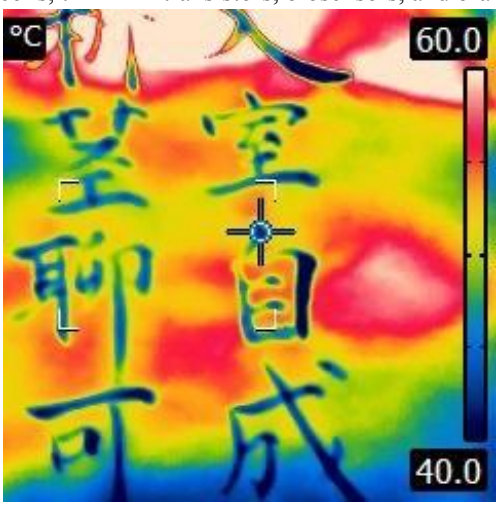
Above: The left picture shows the blurring effect of traditional Chinese calligraphy ink with decreased concentration from top to bottom whereas the right picture with MXene inks shows sharp effects with whole range concentration. On the right: Calligraphy artwork produced by Teng Zhang using MXene ink and painted with a traditional calligraphy brush.

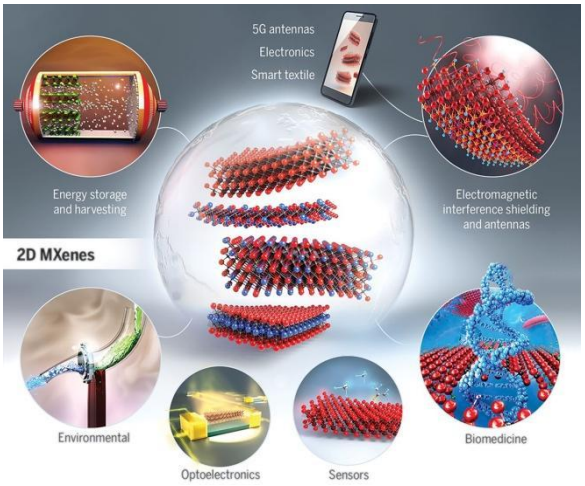
The text in the picture can be translated as "An orchid boutonnière will enrich your presence with its pleasant fragrance."

MXenes are an emerging class of 2D materials, also known as transition metal carbides and nitrides. They have been shown to offer many potential applications in electronics, energy storage, and other areas thanks to their unique combinations of properties, especially solution processability and high-electrical conductivity that exceeds that of the famous 2D material, graphene. Researchers from the A.J. Drexel Nanomaterials Institute led by Professor Yury Gogotsi demonstrate MXenes as an ideal material for calligraphy ink. The hydrophilic (water-loving) surface readily allows dispersity in many solvents, including water, and good adhesion to hydrophilic substrates, such as paper; all binder-free and bleed-free. So far, more than 50 related compositions of MXenes have been created, offering an amazing diversity of properties and colors, forming a family of bleed-free, electrically conductive,

colored inks for calligraphy, water-based painting, and more.

Gogotsi's students have also photographed the MXene calligraphy with an infrared camera, which reveals the infrared cooling effect; multiple applications can be explored based on this property alone. Other than on paper, such effects can also be created on textiles, walls, or even automobiles. Combined with their biocompatibility, low toxicity, and excellent mechanical durability, MXenes have been explored for a wide array of applications. Beyond inks and paints, research into batteries, OLEDs, solar cells, thin-film transistors, biosensors, and brain neural activity recording has also been performed.





Left: Infrared image of MXene calligraphy showing that characters produced using MXene inks stay cool when the sheet of paper is placed onto a hot plate heated to 60°C. Right: Illustration of MXene applications (from Science, 2021).

When it comes to art, MXene's potential alone is exciting. An artist could light up a room, literally, through their brushstrokes! With so many advantages and features not available through traditional inks, MXenes are set to become the premium ink choice not only for calligraphers to create stunning works of art that may last centuries, but for all artists who work in the paint medium, as well as for scientists, engineers, and designers creating next-generation electronic products and clothing. One can write electrical circuits or create electronic tattoos with MXene inks, which can be used in the quickly developing field of flexible, printable, and wearable electronics for healthcare and many other applications.

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