Novel flexible piezoresistive sensor based on 2D $Ti_3C_2T_x$ MXene

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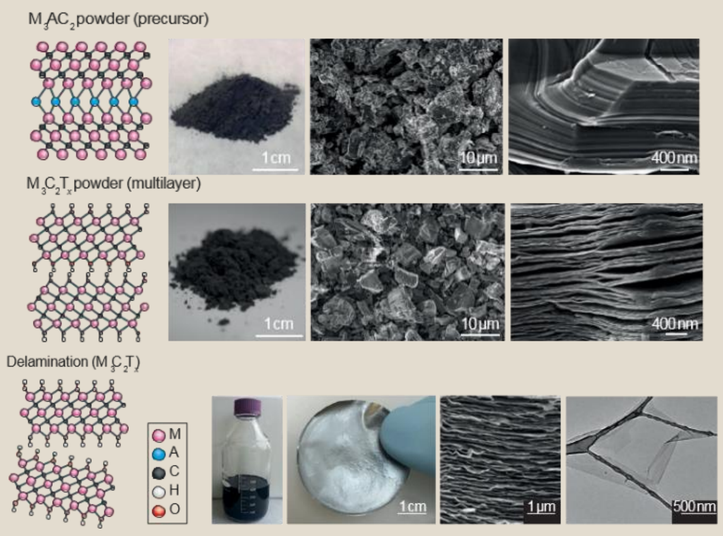
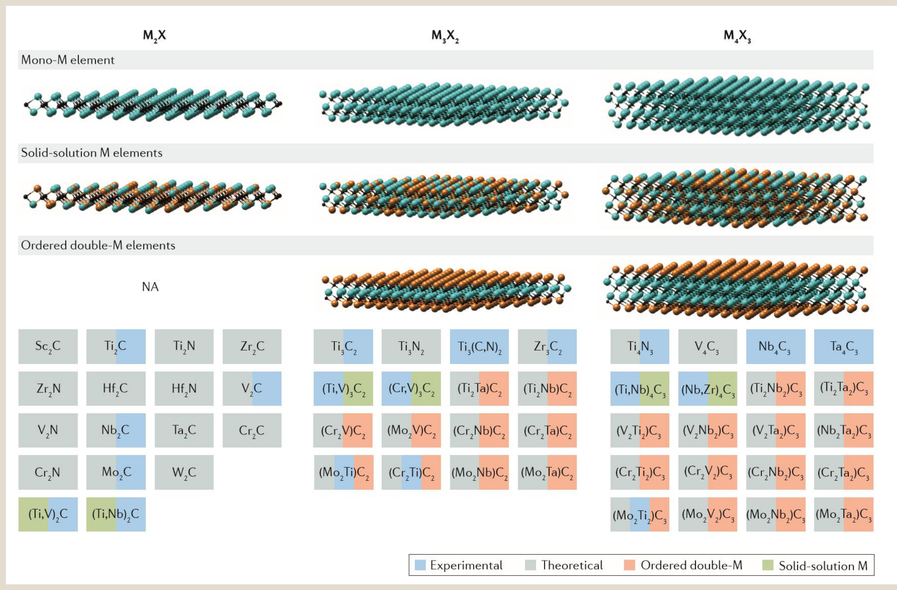
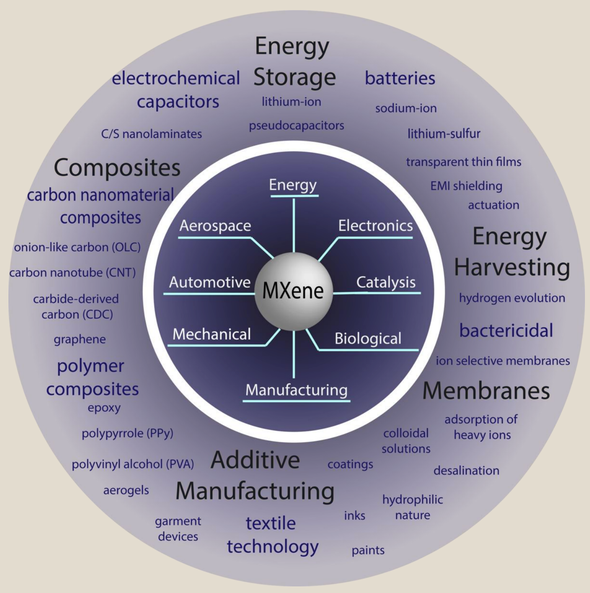
Motivation

- Stretchable and wearable strain-sensing devices are appropriate for motion detection, biomedical monitoring, human-machine interaction. These pressure sensors are working based on numerous electrophysical phenomena's such as piezoelectric, capacitive and piezoresistive reactions towards mechanical stretching [1]. Piezoresistive sensors are highly favored due to their features like high sensitivity, fast response, easy fabrication and low energy requirement. They are generally fabricated using a suitable polymeric matrix and electrically conductive fillers, such as graphite, graphene or carbon nanotubes.
- **MXenes** are a relatively new family of (2D) transition metal carbides, nitrides or carbonitrides, produced by the selective chemical etching of "A" from MAX-phases, where M is a transition metal, A is a group IIIA or IVA element and X is C or N. These nanomaterials are first reported in 2011 by the Gogotsi and Barsoum groups [2]. These materials have received tremendous attention from the scientific community due to their excellent physiochemical properties, electrical conductivity and hydrophilicity [3].
- Herein, we report the **preparation, characterization and piezoresistive** individualities of semiconductive, electrospun mats composed of **copolyamide 6,10 and $Ti_3C_2T_x$**. We observed that the relative resistance of the sensor increased with an increase in the $Ti_3C_2T_x$ content, and the materials with higher electrical conductivity showcased a significantly higher sensitivity to applied pressure until reaching the percolation limit. (font size can be increased)

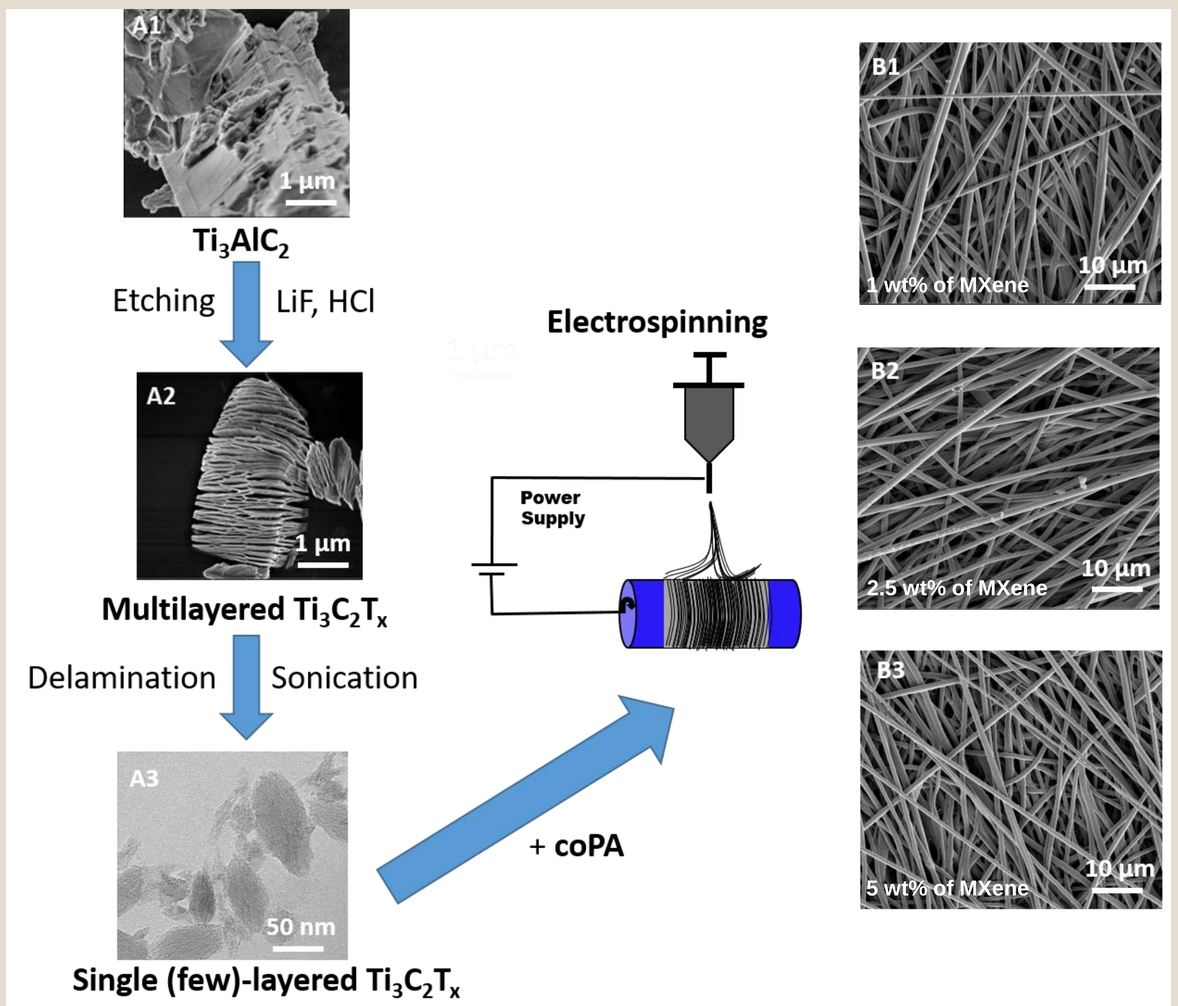
MXenes



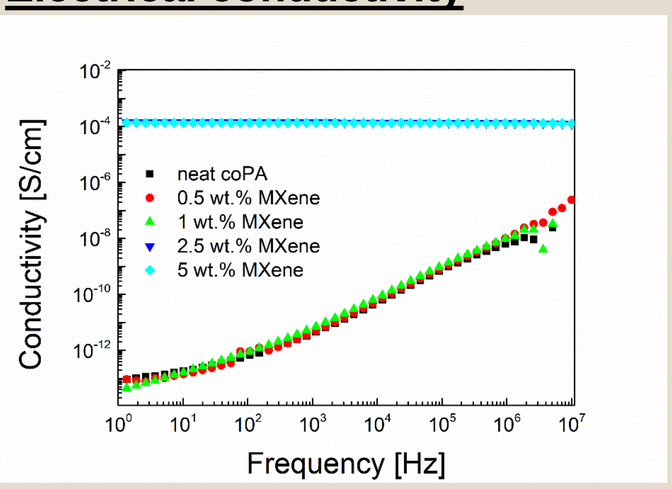




Schematical illustration of coPA and $Ti_3C_2T_x$ composites

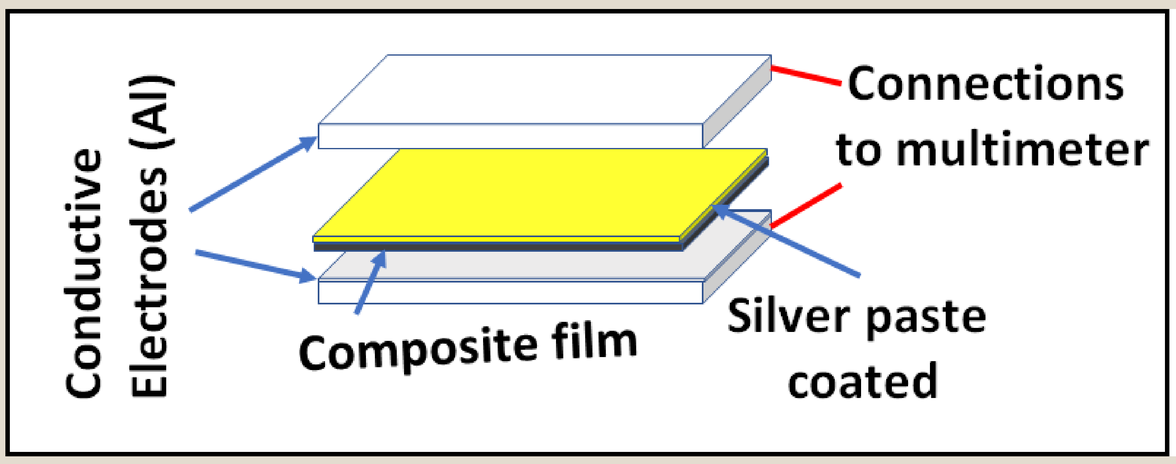


Electrical conductivity

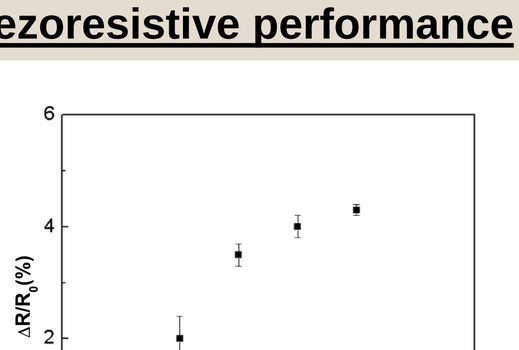


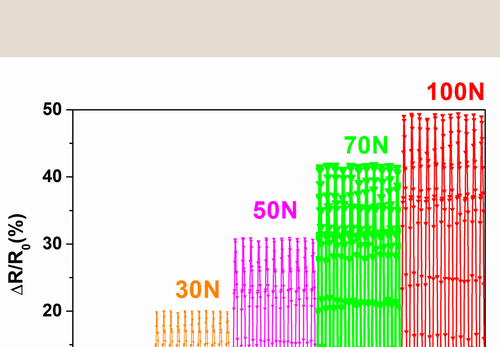
- Neat coPA and its composites filled with **0.5 and 1 wt.% $Ti_3C_2T_x$** indicates a **nonconductive** behavior.
- The **electrical conductivity increases** if the filler **increases from 2.5 wt.% $Ti_3C_2T_x$** loading with a modification of eight orders of magnitude.
- The real part of the electrical conductivity is virtually constant for the entire frequency range, demonstrating the **conductive character** of the materials.

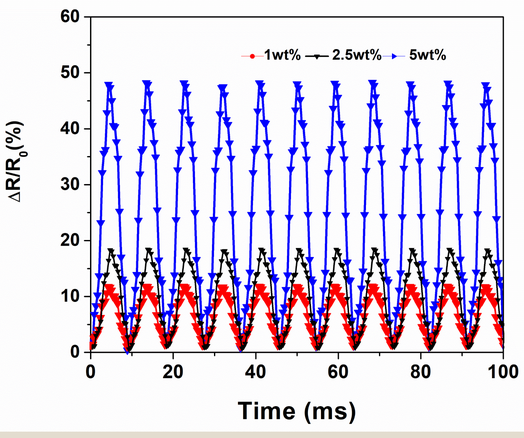
Sensor fabrication



Piezoresistive performance







- The pressure sensor's response to **light finger tapping** (20 N force) with cycling experiments.
- The relative resistance was recorded with simultaneous application of force applied in the range of 20-100 N.
- The sensor had a thickness of 0.1 mm.

Conclusion remarks

- ✓ **Electrospun** nanocomposite mats composed of **copolyamide** 6,10 and **$Ti_3C_2T_x$** were successfully prepared.
- ✓ The electrospun mats were tested as **piezoresistive** sensors, and the relative resistance (A_R) of the sensor increased with an increase in the $Ti_3C_2T_x$ content.
- ✓ The high **electrical conductivity** of the materials resulted in a pointedly high sensitivity to the applied pressure.
- ✓ Changes due to **pressure-induced resistivity**, also increased with an increase in the **applied force**.

References

[1] K.K. Sadasivuni et al. In *Biopolym. Compos. Electr.* **2017** 437–457.
[2] M. Naguib et al. *Adv. Mater*. 23 **2011** 4248–4253.
[3] M. Naguib et al. *ACS Nano* 6 **2012** 1322–1331.

Acknowledgements

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