ROBERT GORDON UNIVERSITY ABERDEEN

Enhancing Epoxy Polymer Composites with MXene Nanosheets for Improved thermal performance

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Overview of presentation

- Introduction
- What are MXene
- Nanocomposite fabrication
- Mechanical testing of nanocomposites
- Characterization techniques
- TGA & DSC
- Discussion
- Potential applications and future prospect
- Q&A

Introduction

- Thermosetting epoxy polymers are chosen for fibre-reinforced composites for their superior strength and stiffness, yet their brittleness and low fracture toughness constrain high-end applications.
- Improving the thermal performance of epoxy composites enhances their durability and safety in high-temperature environments.
- Traditional fillers improve thermal conductivity in epoxy composites is limited by challenges such as poor dispersion, increased viscosity, and potential mechanical property trade-offs.
- MXene offer superior physical and mechanical characteristics, making them ideal candidates for creating multifunctional polymer nanocomposites.

What are MXene?

- MXenes, discovered in 2011 at Drexel University, are 2D materials derived from MAX phases (transition metal carbides, nitrides, or carbonitrides).

- MXenes have a layered structure with transition metals (e.g., titanium, vanadium) and carbon/nitrogen atoms. Common MXenes include $Ti_3C_2T_{\_x}$, $Nb_2CT_{\_x}$, $Ti_3CN_{\_x}$, and $V_2CT_{\_x}$

- The unique architecture of MXenes imparts outstanding properties such as high electrical conductivity, exceptional mechanical strength, and adjustable surface chemistry.

- MXenes are fascinating due to their high surface area and their utilization in various fields is shown in fig 2.

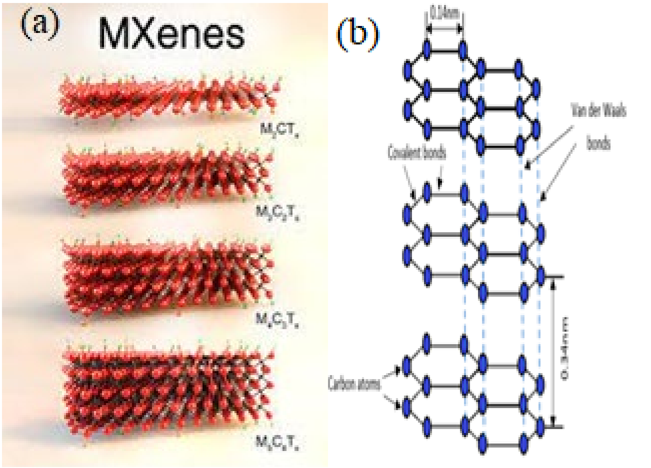


Fig. 1 (a) shows MXene layered structure while (b) shows graphene layers

Fig. 2

Fabrication of MXene/epoxy nanocomposite

Process Parameters:

1. Sonication time: 60 minutes
2. Resin to hardener ratio 2:1
3. Silicone Rubber moulds according to ASTM standards
4. Pre-curing at room temperature while post-cure at 120°C

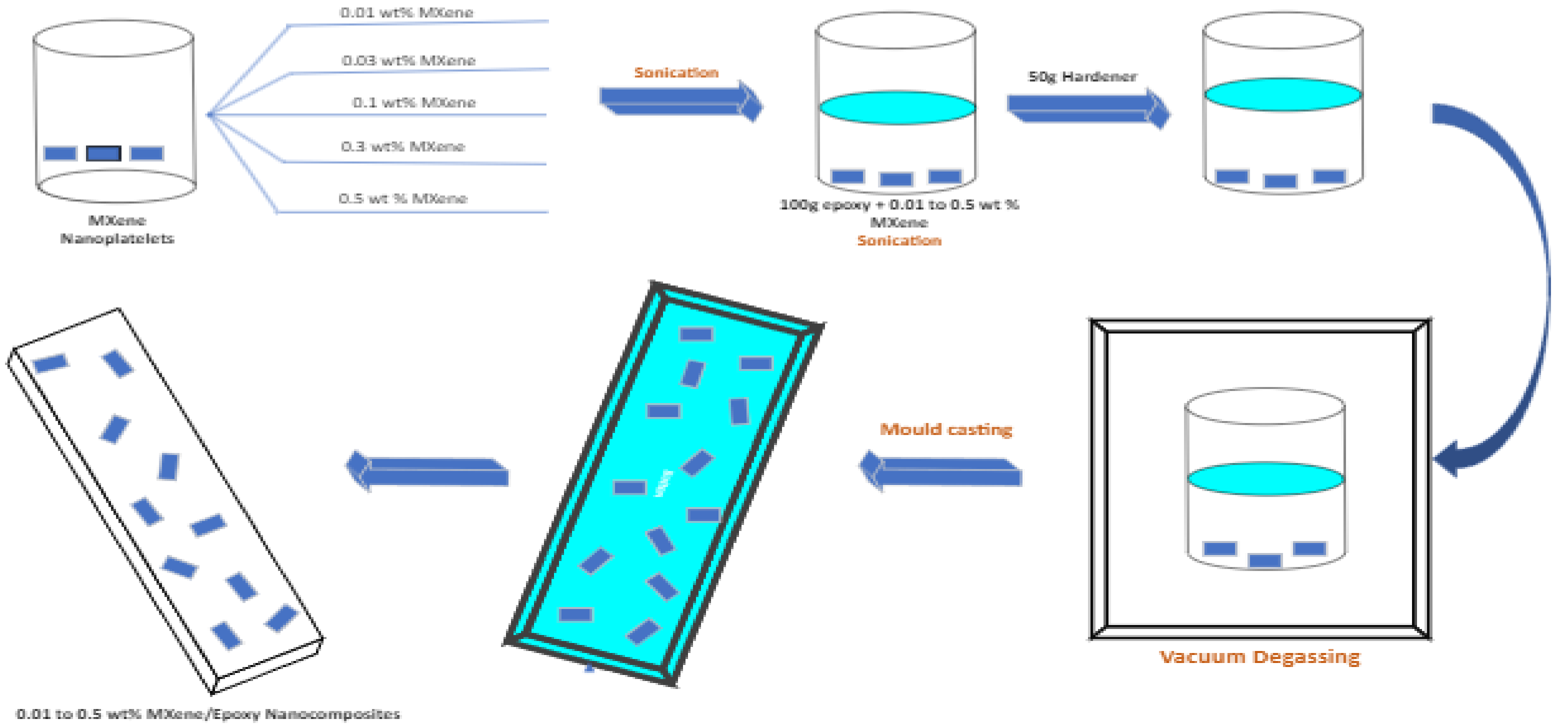
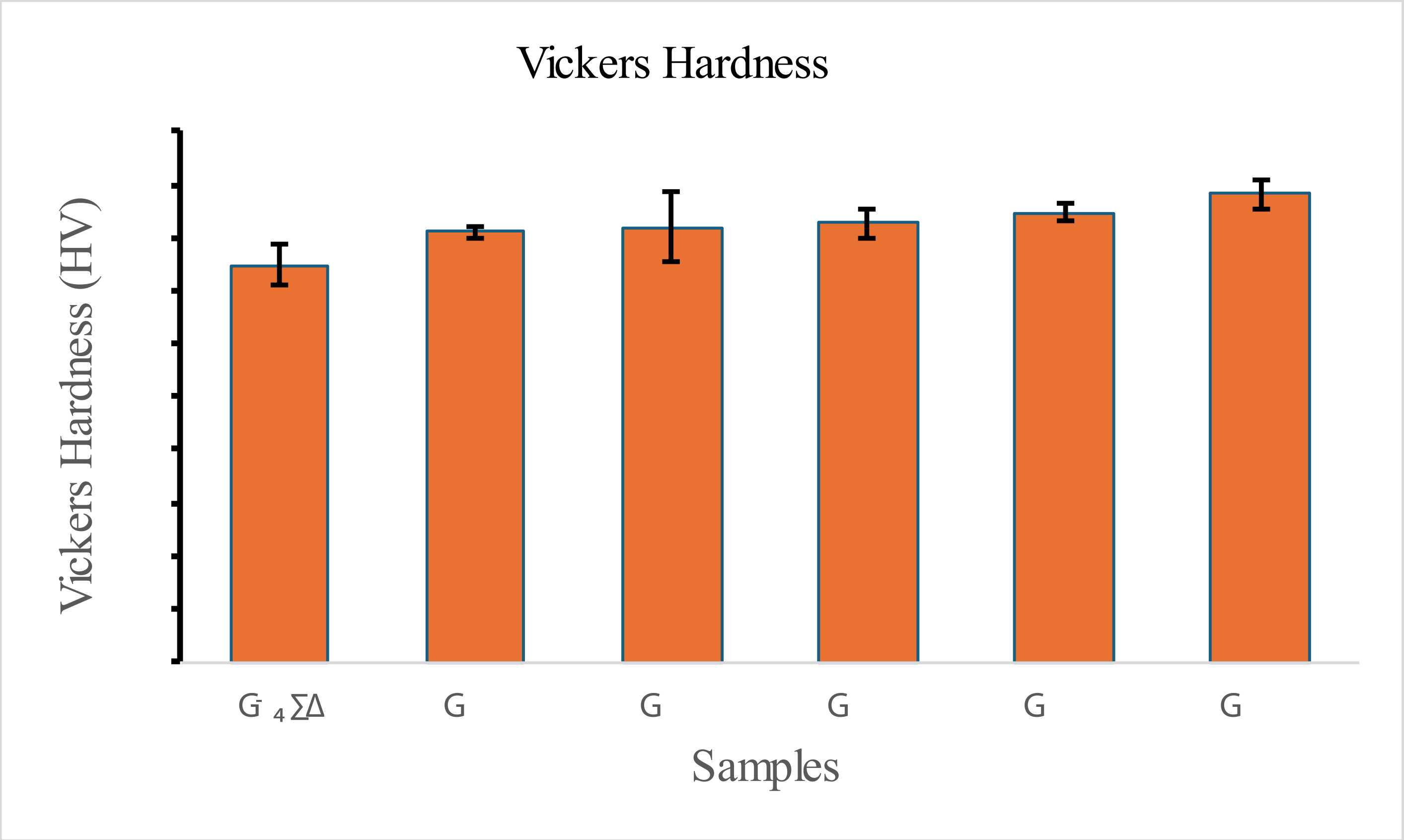


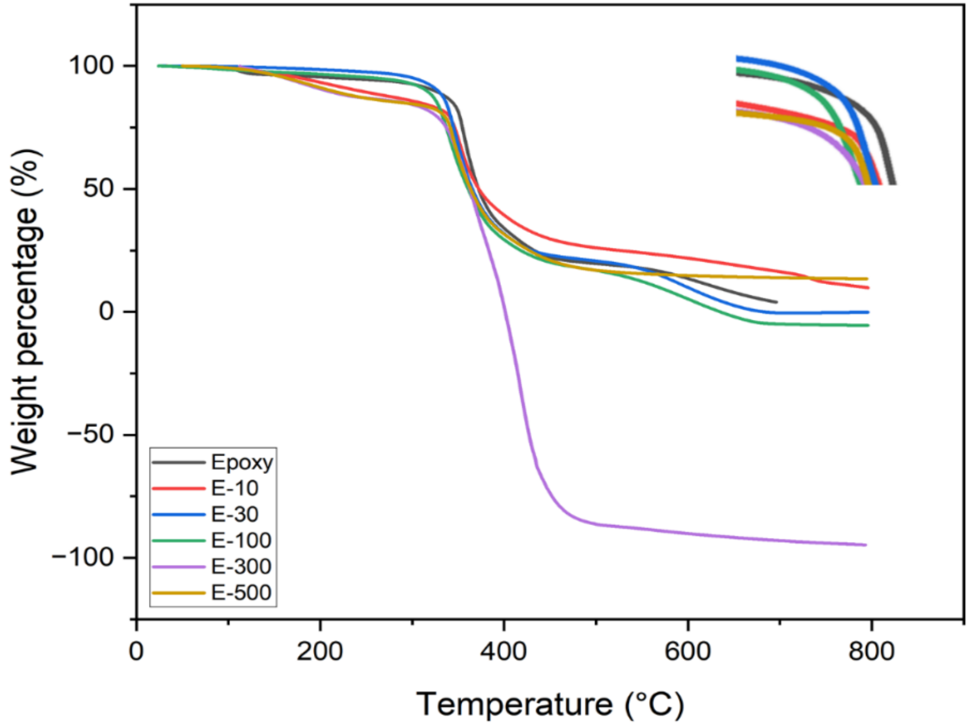
Fig. 3 Schematics of fabrication of nanocomposite

Mechanical testing of nanocomposites

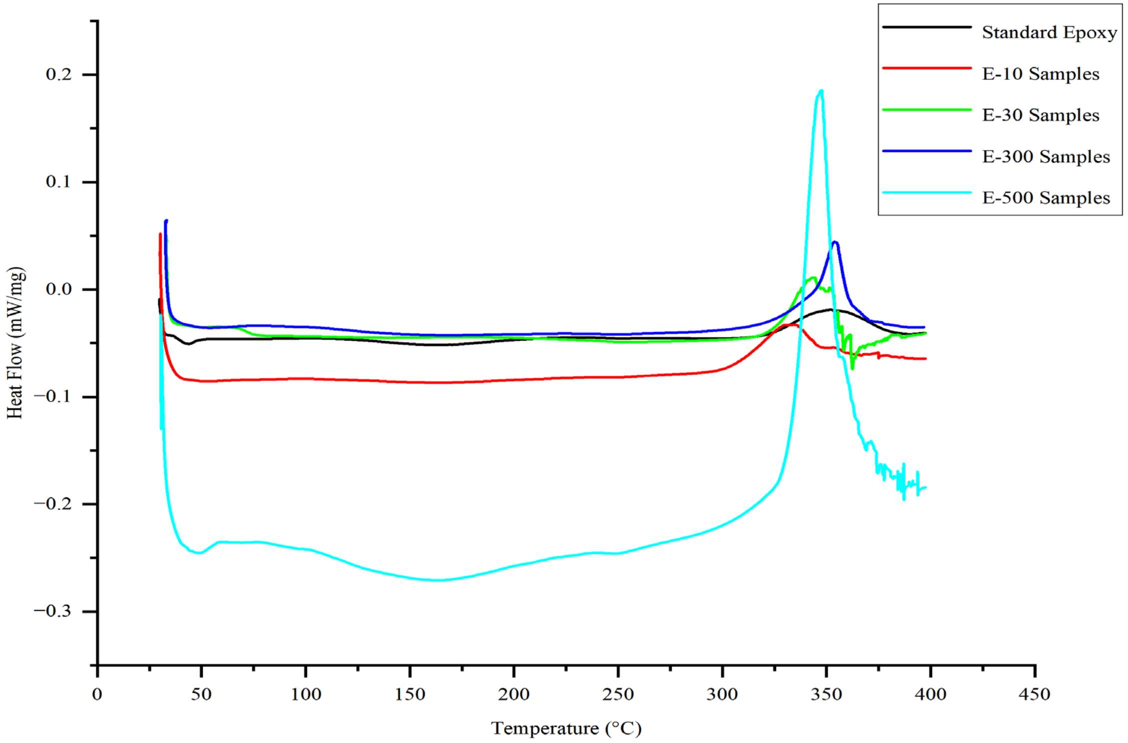


Characterization Techniques

1. Thermogravimetric Analysis (TGA)



2. Differential scanning calorimetry



Discussion

- 0.5 wt. % loadings resulted in highest Vickers hardness value.
- 8°C increase in the glass transition (Tg) with 0.5 wt. % loading
- 5°C elevation in the melting point at 0.3 wt. % loading
- An increased thermal stability was observed in E-10, E-100, and E-500 samples compared to Standard epoxy.
- On contrary, inconsistency in thermal stability is observed due to agglomeration of NPs.

Why MXene enhance thermal stability?

- The Unique layered structure and metallic nature facilitated efficient heat transfer.
- Dispersed MXene nanosheets in epoxy resin created thermal pathways
- Strong interfacial adhesion
- Improved thermal stability likely due to nanosheets' barrier effect slowing decomposition.

Potential applications

- Electronics and thermal management
- Aerospace and automotive
- Energy storage and conversion
- Sports equipment, protective nanocoating

Future Prospect

- Scalable and cost-effective synthesis
- Tailoring properties and functionalities
- Modelling and simulations
- Environmental and safety considerations

Acknowledgement

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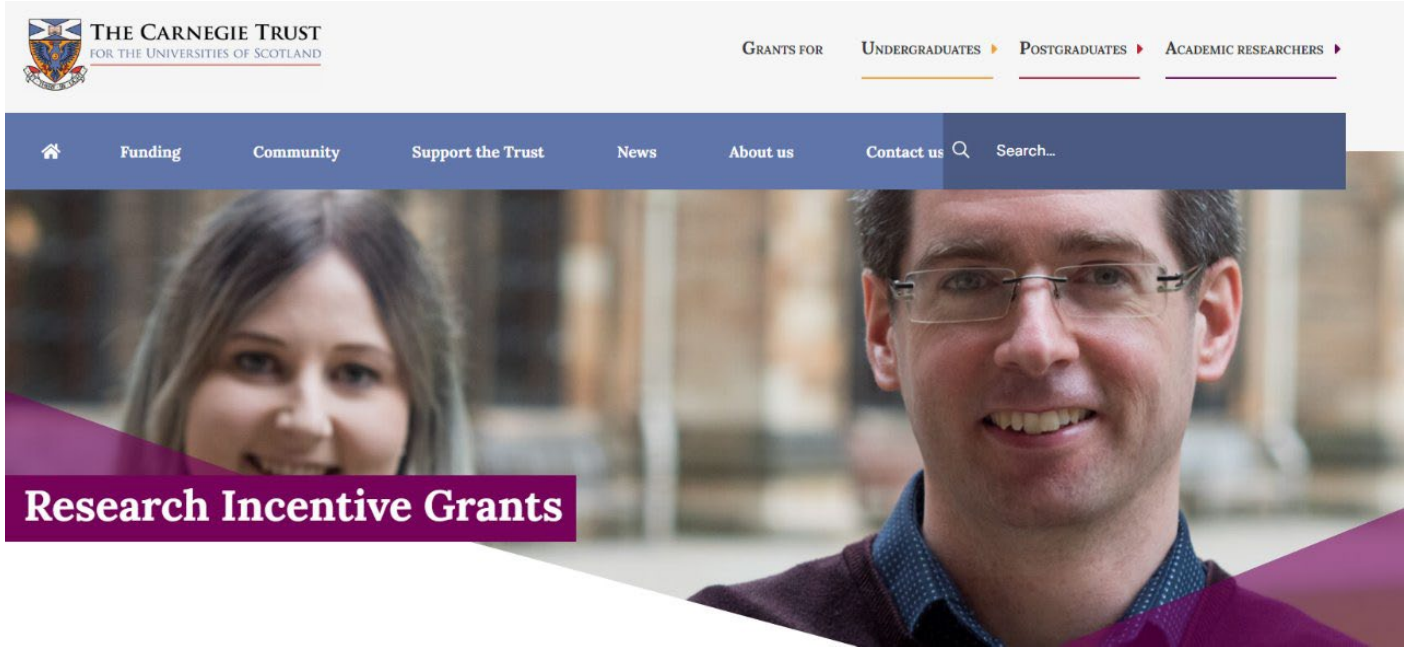

Thank you