

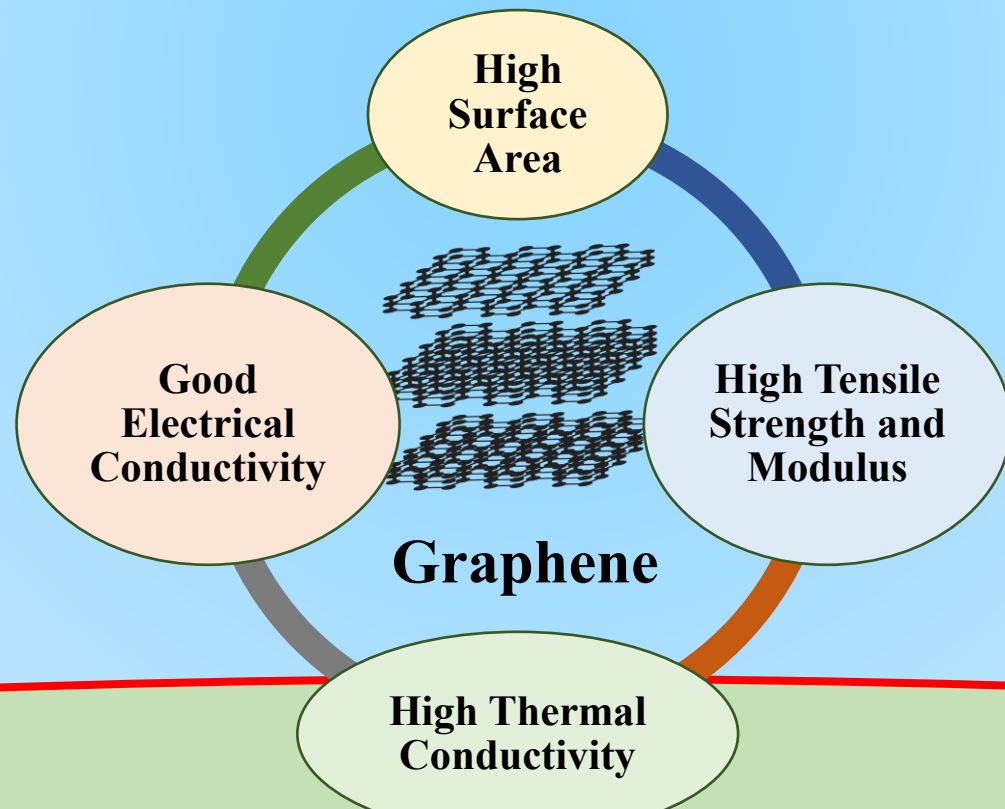
Effects of Few-layered Graphene Encapsulation on Morphology and Mechanical Properties of Polyamide 6 Nanocomposites

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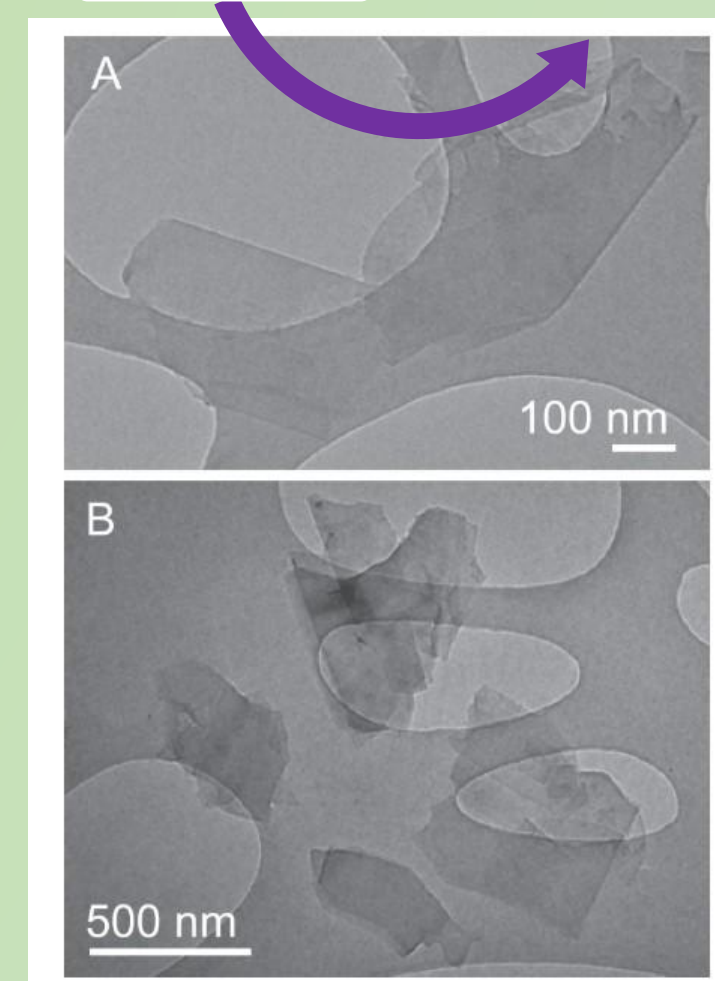
Introduction

- ❖ PA6 is a very good engineering plastic with Tensile strength (TS) of 60-90 MPa and Young's modulus (YM) ~ 3 GPa.
- ❖ PA6 is a semi-crystalline polymer with T_g between 40-60 °C and a sharp T_m at about 230 °C.
- ❖ PA6 and Graphene have Surface free Energy of 38-45 mJ/m² and 42-48 mJ/m² respectively.
- ❖ Graphene acts as a heterogeneous nucleating agent.



Material Processing

- GB 3X
- EG 3806

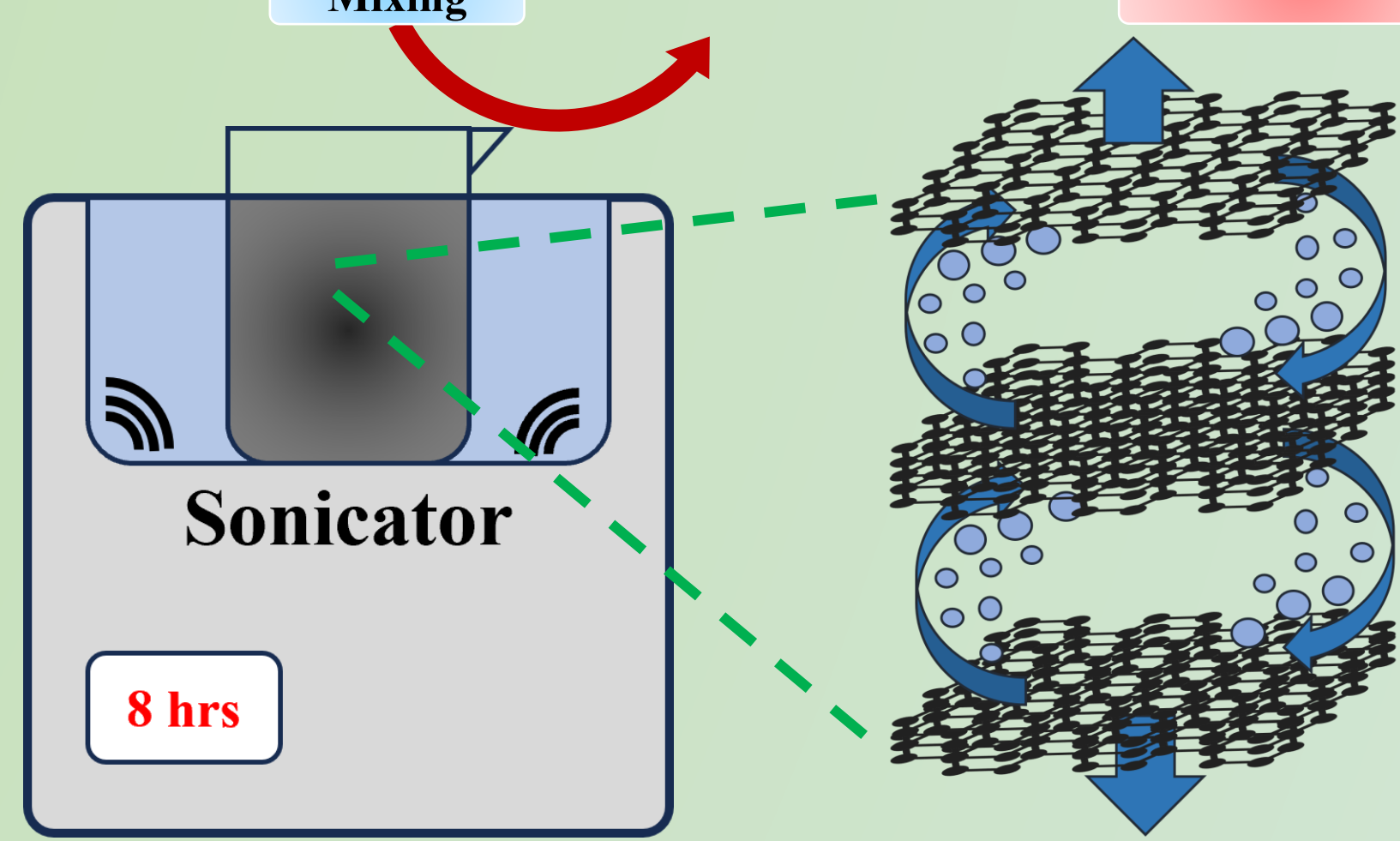


- Sonication
- Ultrasound results delstacking

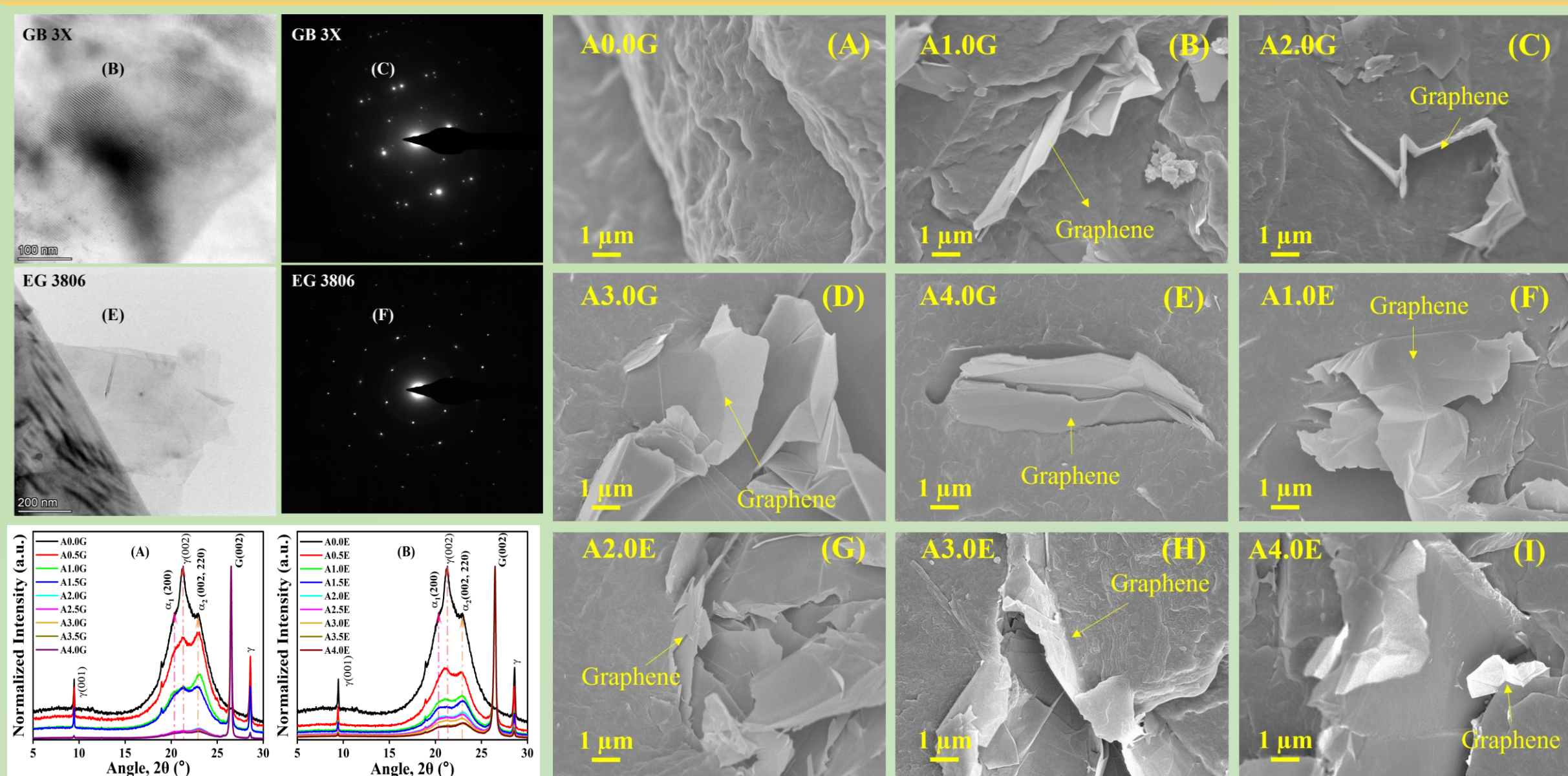
- Stirred with PA6 by a agitator
- High Shear Mixing

- Evaporation
- Heating on a Hot Plate
- Vacuum Drying

- Heat and shearing leads to a greater extent of exfoliation
- Melt - Mixing

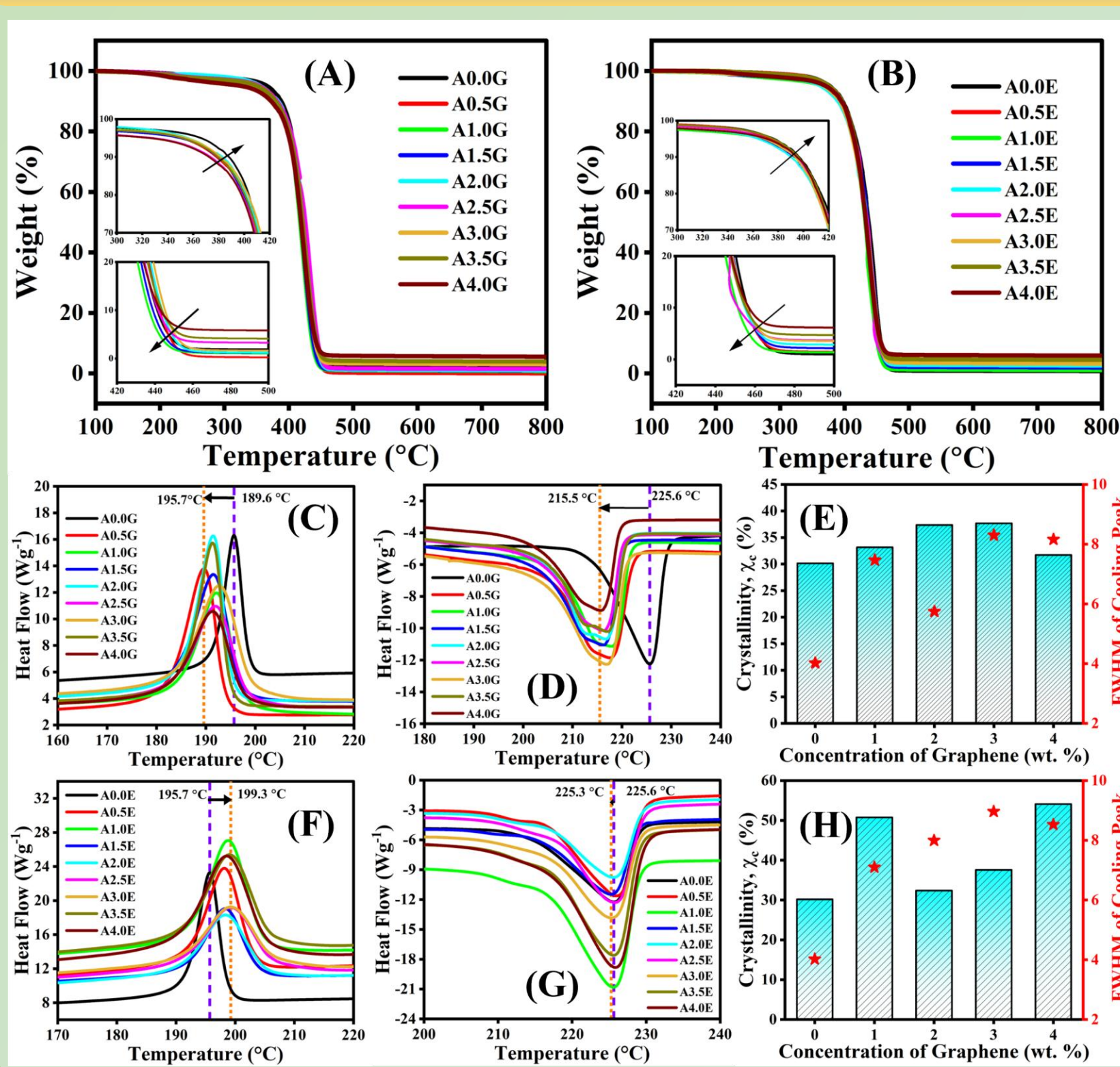


Crystallographic and Morphological Analysis



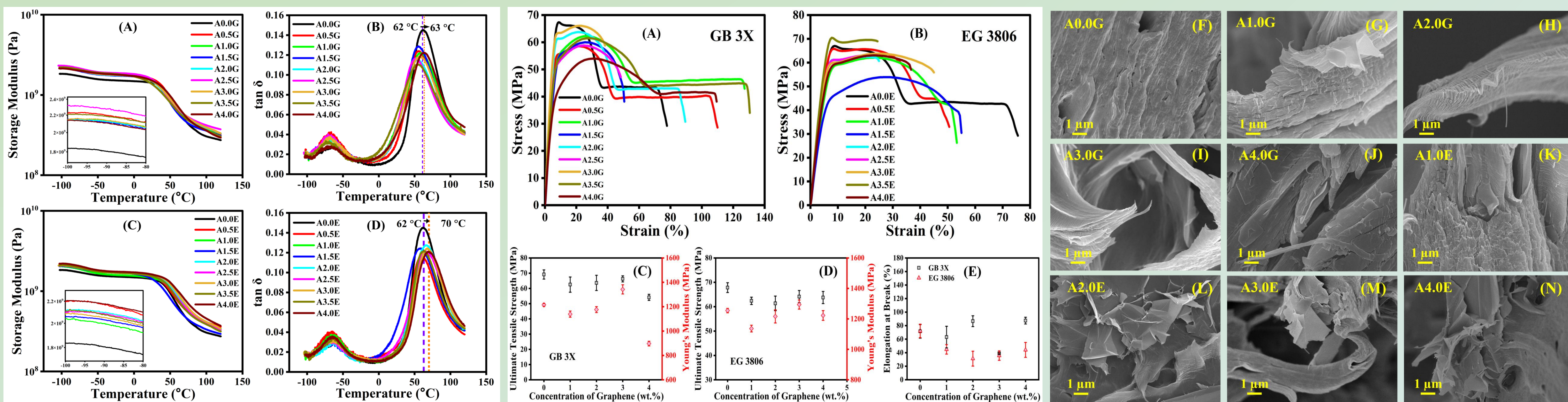
- Pure PA6 showed peaks of α_1 , γ , and α_2 polymorphs.
- PA6/graphene nanocomposites showed the (002) sharp peaks of Graphene at 26.6 °.
- PA6-wrapped graphene sheets are observed.
- Graphene delamination is prominent at higher concentration.

Thermal Properties



- Degradation of nanocomposites starts at ~ 350 °C and ends at ~ 480 °C.
- Crystallization peak shifts to 190 °C and 199 °C for nanocomposite with GB 3X and EG 3806.
- Melting peak shifts to 216 °C and 225 °C.
- %Crystallinity of nanocomposites decreases with an increase in nanomaterials.

Results and Discussion



- PA6/graphene nanocomposites exhibit higher storage modulus compared to neat PA6 throughout the whole range of temperature for both the grades of graphene.
- There is a shift of T_g from 62 °C to 63 °C and 70 °C for GB 3X and EG 3806.
- Young's Modulus of the PA6/graphene nanocomposites with both the graphene increases to a significant amount.
- Tensile strength of the nanocomposites remains almost the same.

Conclusion

- EG 3806 exhibited a significant reinforcement, manifested by an increase in the tensile strength to 70 MPa and Young's modulus to ~ 1.5 GPa at 3.5 wt% loading of graphene in the PA6 matrix.
- Nanocomposite with 4 wt.% EG 3806 showed a hardness of 183 MPa, 4 wt.% GB 3X had a hardness of 170 MPa.
- Above the glass transition temperature, composites show an improved value of storage modulus accompanied by an increase in the value of T_g .

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References

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