Graphene oxide reinforced polymer nanocomposite using ultra-high-molecular-weight polyethylene oxide and tannic acid

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The mechanical reinforcement of polymers with graphene-based materials typically involves compromises, for instance, an increase in their strength is accompanied by a reduction in elongation at failure. In this work, we demonstrate how this compromise can be overcome with appropriate interface chemistry between graphene and the polymer, specifically, ultra-high molecular weight polyethylene oxide (UHMW PEO) reinforced with graphene oxide (GO) and tannic acid (TA) as a coupling agent. By varying the processing conditions, including mixing and drying methods, as well as the composite formulation, we have optimized the dispersion and filler-matrix interaction and the ultimate improvements in mechanical strength. The results reveal two scenarios; one where we achieve dramatic improvements in elastic modulus, yield strength and ultimate tensile strength without reducing ultimate elongation, or another where we achieve moderate improvements in all these mechanical properties as well as improved elongation. In either case, there is no compromise in mechanical properties. Furthermore, we take advantage of the recyclable nature of this composite system by dissolving the test films and re-casting them and demonstrate that the graphene enhancement of mechanical properties can be carried over to the recycled material. These results demonstrate that a careful tailoring of the graphene and polymer interface can deliver significant and uncompromising improvements to the mechanical properties in polymer nanocomposites as well as improving their carbon footprint through enhanced recycling.

References

[1] Li, D. and G.S. Sur, Macromolecular Research, 2014. 22(2): p. 113-116.
[2] Al-Bermany, E. and B. Chen, Polymer international., 2021. 70(3): p. 341-351.
[3] Suner, S., et al., Composites Part B: Engineering, 2015. 78: p. 185-191.
[4] Li, X., et al., Polymers (Basel), 2021. 13(4).

Figures

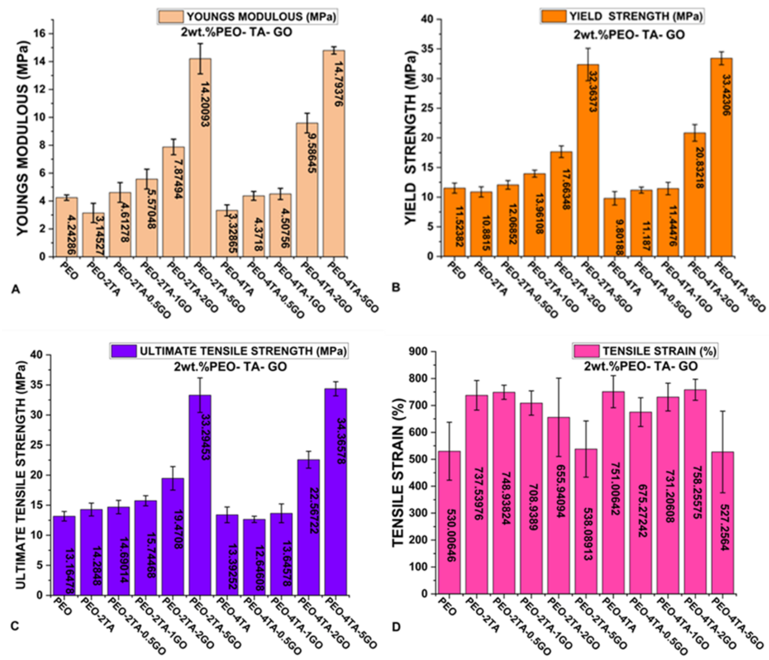

Figure 1: Schematic shows mechanical testing results of virgin material PEO, PEO/TA, & PEO/TA/GO. A) Young's modulus, B) yield strength, C) ultimate tensile strength, D) tensile strain.