

HIGH DURABILITY BIO-POLYESTER RESIN USING GRAPHENE AND PALM OIL DERIVATIVES FOR COMPOSITE APPLICATIONS

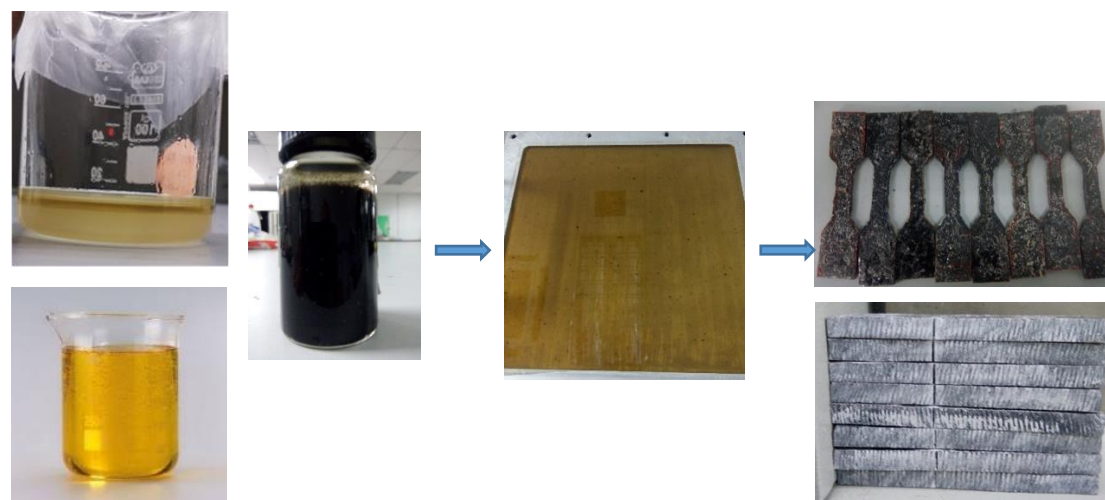
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Product Background

- Research and development of eco-friendly products such as bio-based unsaturated polyester resin helps differentiate product offerings.
- Graphene-enhanced fiber-reinforced biopolymer (gFRP) composites is a new approach in improving the biopolymer properties and applications.
- Since Malaysia is abundantly available palm oil and natural resources, new approach by blending palm oil and graphene reinforcement is a promising approach to replace the current synthetic product in market.

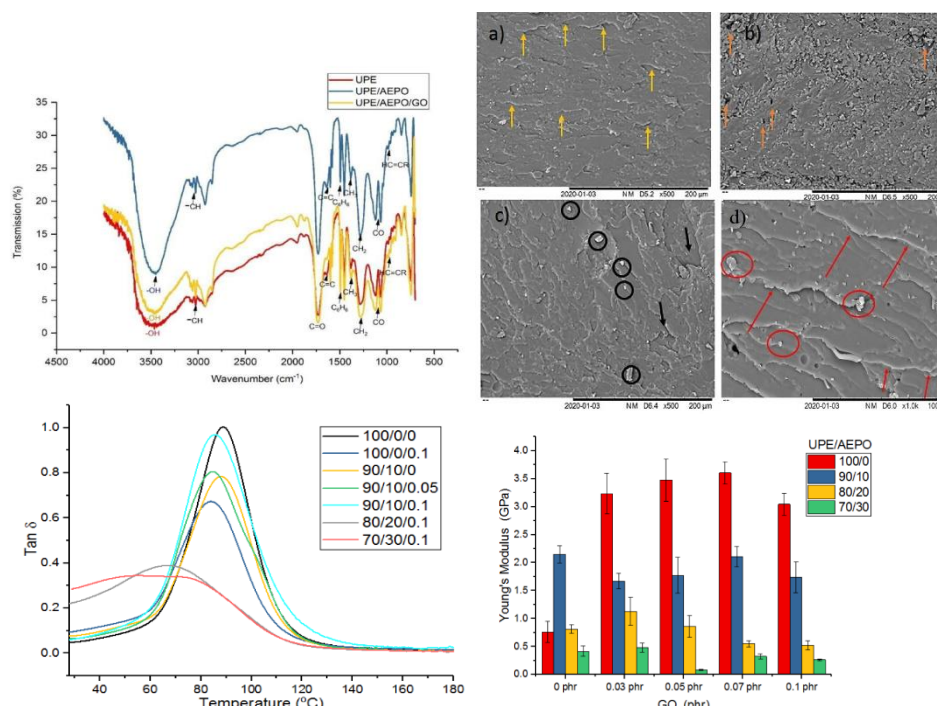
State of the Art



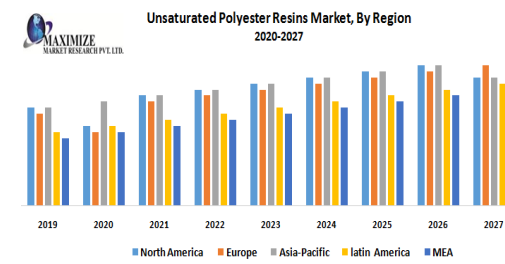
Novelty/ Originality/ Inventiveness

- Good compatibility of polymer blend.
- Formulated with 10% reduction of synthetic polyester to palm oil.
- Higher stiffness and strength than commercialized polyester.
- Higher thermal stability than commercialized polyester.

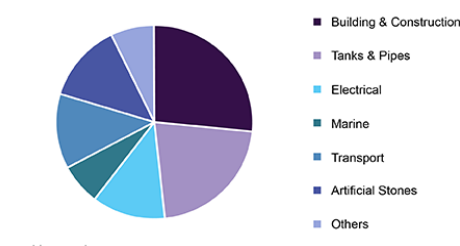
Product Characteristics/Results



Marketability & Commercialisation



Global unsaturated polyester resin market share, by end use, 2019 (%)



Environmental Impact

- Reduce reliance on petroleum resources.
- Enhance local palm oil production.

Publication

1. Bio-based thermoset nanocomposite derived from vegetable oil: a short review. *Rev Chem Eng* 30 (2) 167-182. 2014. (Q1: IF 5.315)
2. Tailoring Graphene Reinforced Thermoset and Biothermoset Composites. *Rev Chem Eng* 36 (5) 623-652. 2020. (Q1: IF 5.315)
3. Effect of Kenaf/Empty Fruit Bunch (EFB) Hybridization and Weight Fractions in Palm Oil Blend Polyester Composite. *Natural Fibers*, DOI: 10.1080/15440478.2020.1788686, 2020. (Q1: IF 2.622)
4. Vegetable oil-based epoxy resins and their composites with bio-based hardener: a short review. *Polymer-Plastic Technology and Materials*, 1-6. 2019. (Q4)
5. Novel Bio Based Resins from Blends of Functionalized Palm Oil and Unsaturated Polyester Resin. *Materials Research Innovations* 18 (S6) 326-330. 2014. (Q4: IF 0.83)
6. Mechanical Properties of Graphite Filled Unsaturated Polyester and Unsaturated Polyester/Palm Oil Blend Resin. *Materials Science Forum*, 981, 105-155. 2020. (SCOPUS)
7. Characterisation and mechanical properties of unsaturated polyester/acrylated epoxidised palm oil polymer blend at different acrylated epoxidised palm oil processing method. *IOP Conference Series: Materials Science and Engineering* 458 (1), 012026. 2018. (SCOPUS)
8. Mechanical Properties of Hybrid Thermosets from Vinyl Ester Resin and Acrylated Epoxidized Palm Oil (AEPO). *Applied Mechanics and Materials* Vol. 695, pp. 73-76, Nov. 2014. (SCOPUS)

Properties	Synthetic UPE	g-UPE/AEPO resin
Tensile Modulus (GPa)	0.76	1.74 (+128.95%)
Impact Strength (J/mm)	3475.6	3689.5 (+6.15%)
Degradation Temperature (°C)	T _{10%} - 307.66° C T _{50%} - 378.50° C	T _{10%} - 309.33° C (+0.54%) T _{50%} - 380.33° C (+0.48%)

Cost Analysis

Production of 10 tons = 10,000 kg = 10,160 L resin

Chemical	Price (RM)	Usage	Total (RM)
Polyester Resin (A) MEKP	30/kg 25/kg	90% 1.5%	270,000
Acrylic Acid (B)	223/1 L	(1/9)%x10%	25,174
Epoxidized Palm Oil (B)	Free	10%	-
Hydroquinone (B)	281/2.5L	1%x10%	1,142
Amine (B)	339/2.5L	1%x10%	1,378
Initiator (C)	215/250g	1.5%	129,000
Graphene oxide (c)	800/250 ml	0.1%	32,512
Synthetic UPE	303750	g-bioUPE	459206 (+50.18%)

Applicability



Status of Innovation

- Product readiness: 3
- TRL level: 2

Achievement/Award

- Silver medal i-Finog 2019

Potential Collaboration/Industrial Partner:

