Design and Manufacturing of Graphene Based Nano Composites

STUDENTS / UNIVERSITIES

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INTRODUCTION

Graphene is an allotrope of carbon in the form of a 2-dimensional hexagonal lattice in which one atom forms each vertex. Common graphene synthesis approaches include mechanical exfoliation from graphite, chemical vapor deposition, and reduction of graphene oxide through thermal and chemical routes. However, the high production cost and hazardous synthesis routes have diminished the use of graphene in thermoplastic composites. Therefore, several attempts have been made to find alternative cheap sources like waste materials for the fabrication of graphene. In the present work, graphene based composites are produced by using waste materials as reinforcer for termoplastic polypropylene (PP) poylmer by melt-compounding process. With the proposed technique, the mechanical properties of the composites were improved significantly. Consequently, more reliable and value-added composite production is possible by using graphene-like structure obtained from waste coffee and tea as a reinforcement in polymeric materials.

MOTIVATION

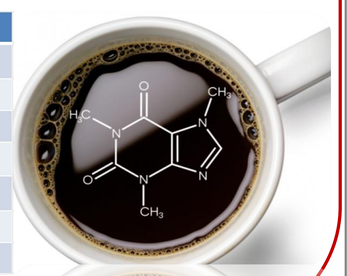
◊ Conversion of waste biobased materials (tea and coffee) into value-added products

◊ Tea and coffee are containing aromatic groups which are good source for graphene synthesis

◊ Graphene like structure fabrication by developing green and recycling processes

◊ Utilization of graphene like structures as a reinforcing agent in thermoplastic composites

Components of raw tea (% wt/wt)		Components of raw coffee (% wt/wt)	
3-10	Catechins	13	Protein
29-33	Polyphenols	13	Oils
3-6	Caffeine	1	Caffeine
8-16	Cellulose	33	Cellulose
5	Potassium	10	Starch
7	Sugars	7	Sucrose
23-45	Other components	23	Other components



Fabrication route of graphene like structures

Waste coffee or tea

Drying

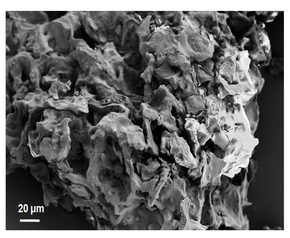
Carbonization under Argon atmosphere

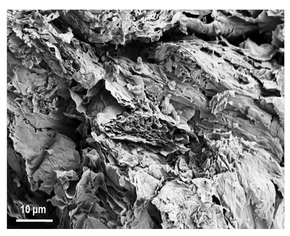
Characterization and verification

Dispersion of graphene in PP matrix by thermokinetic mixer

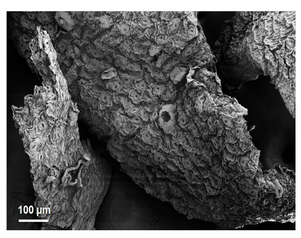
Nanocomposite specimens by injection moulding

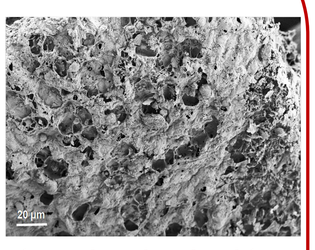
Morphological Analysis





SEM images of waste and carbonized coffee





SEM images of waste and carbonized tea

Findings of SEM characterization

Tea: More porous structure formation after carbonization
Coffee: Formation of layered structure after carbonization

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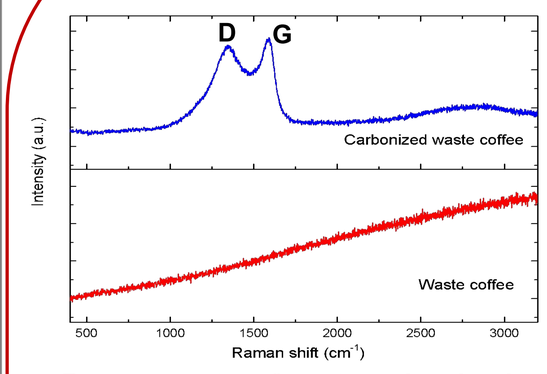
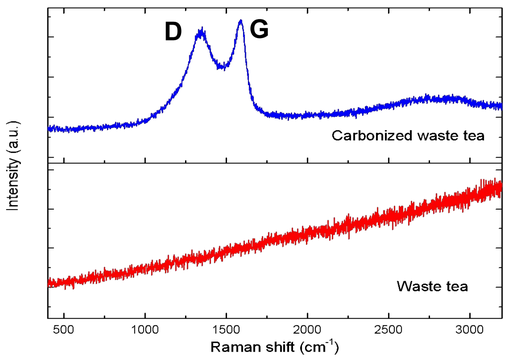
Coffee is more suitable source for graphene synthesis

Characterization results of graphene like structures



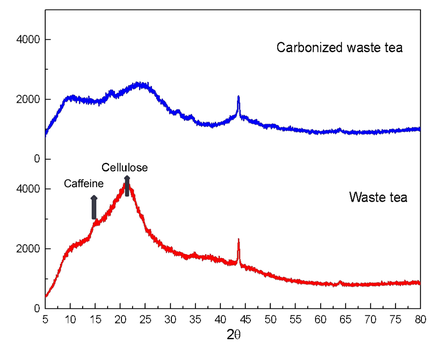
Raman spectra of waste and carbonized coffee



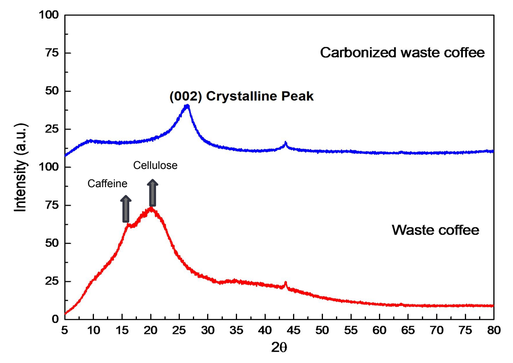
Raman spectra of waste and carbonized tea

Findings of Raman characterization

After direct carbonization, the formation of D and G peaks indicating the formation of carbonaceous structures.



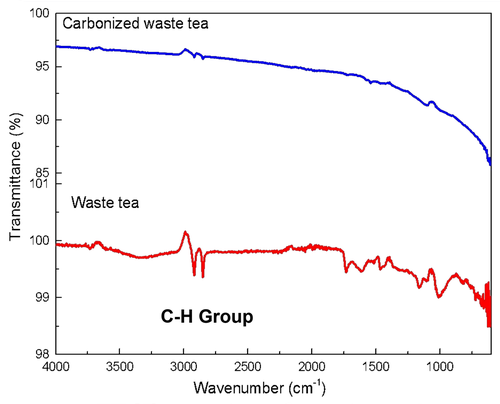
XRD spectra of waste and carbonized tea



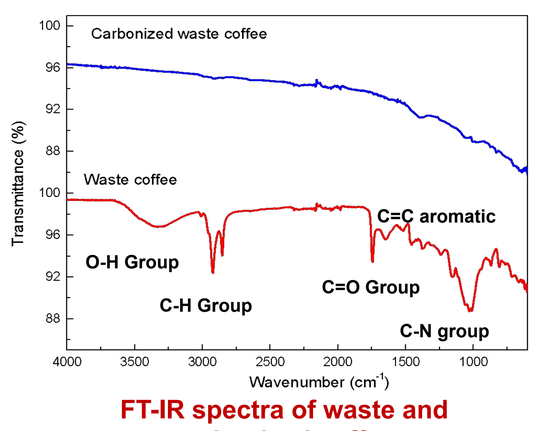
XRD spectra of waste and carbonized coffee

Findings of XRD characterization

- Carbonized coffee has (002) peak at 2θ=28º indicating an increase in the crsytallinity. (002) peak is related to the formation of graphitic structure.
- Carbonized tea has no crystallinity peak indicating graphitic formation and it has amorphous structure.



FT-IR spectra of waste and carbonized tea

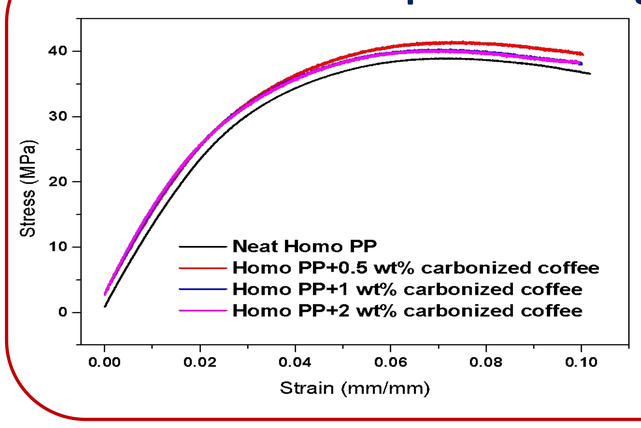


FT-IR spectra of waste and carbonized coffee

Findings of FT-IR characterization

An increase in sp^2 bonds and aromatic groups indicating the formation of graphene like structures after carbonization of waste coffee

3-point bending test results



◇ Flexural strength and modulus values are slightly enhanced by integration graphene from coffee into PP matrix.

CONCLUSIONS

◊ Waste coffee is a promising source for the formation of graphene like structures

◊ Graphene reinforced composite specimens are succesfully prepared by thermokinetic mixing and injection moulding steps.

◊ There is slight improvement in flexural strength in PP composites reinforced by graphene from waste coffee.

◊ Synthesis of graphene from waste coffee is required additional chemical treatments (e.g. purification, catalyst impregnation) to improve the graphene quality.

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