TUNING THE PROPERTIES OF FURAN BASED POLYESTERS VIA THE IN-SITU INCORPORATION OF NANOFILLERS

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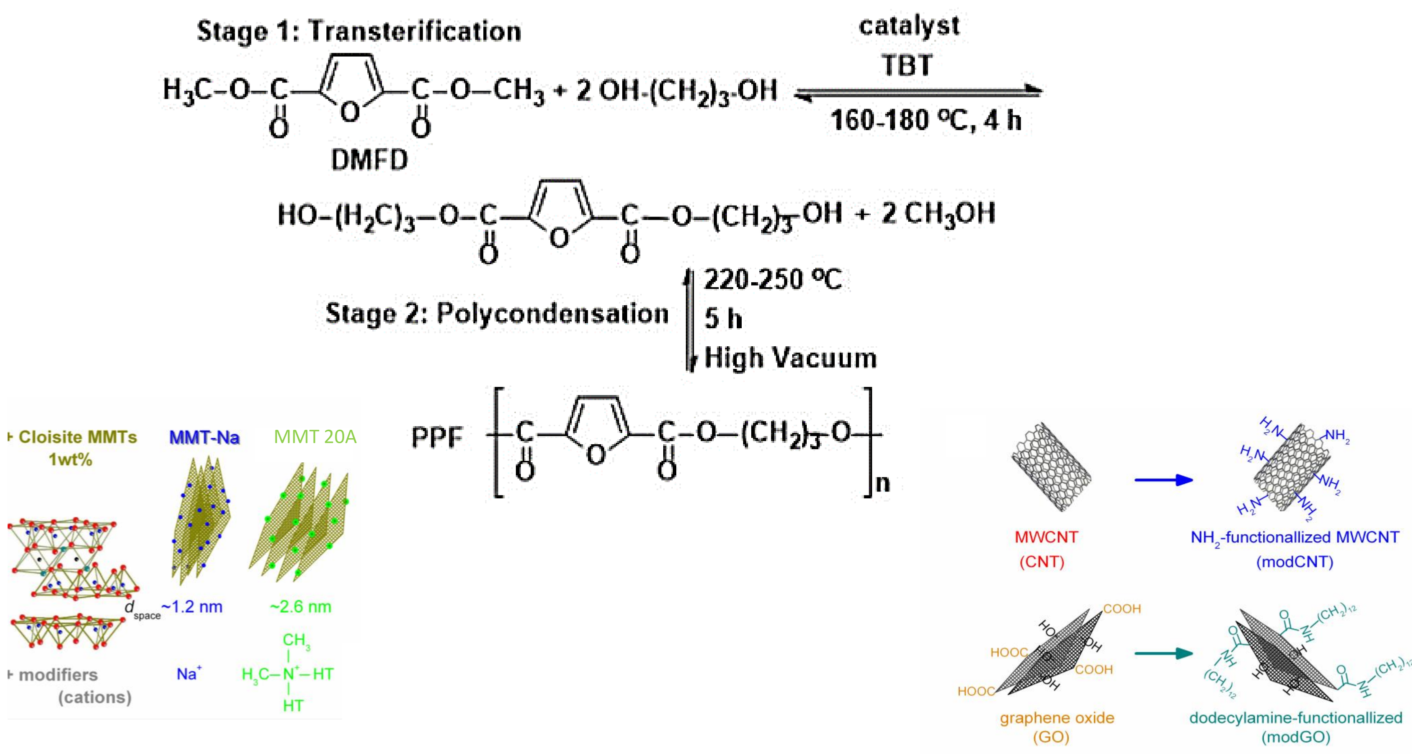
INTRODUCTION

- The inclusion of nanofillers in a polymer matrix has been known for years as a proven method to improve the mechanical, thermal, electrical and gas barrier properties of the pristine materials.
- In nanocomposites, dramatic changes in properties are possible at very low filler loadings.
- This modification of properties is based on the inherent properties of the nanofillers, but also on their dispersion in the polymer matrix, the interface chemistry and nanoscale morphology, as they possess an enormous surface area per unit volume.
- Poly(propylene 2,5-furan dicarboxylate) (PPF) belongs to the furan family of polyesters and is synthesized through the transesterification and polycondensation of DMFD with 1,3-propanediol (PDO). PPF naturally possesses excellent gas barrier properties, making it interesting for potential packaging applications, but it also crystallizes at a very slow rate.
- In this work PPF nanocomposites with various fillers were synthesized and their thermal and mechanical properties were investigated.

EXPERIMENTAL

The nanocomposites were in-situ synthesized via a 2-step melt transesterification and polycondensation reaction. Different inclusions and loadings were employed to check how the properties of the pristine polymer were altered.



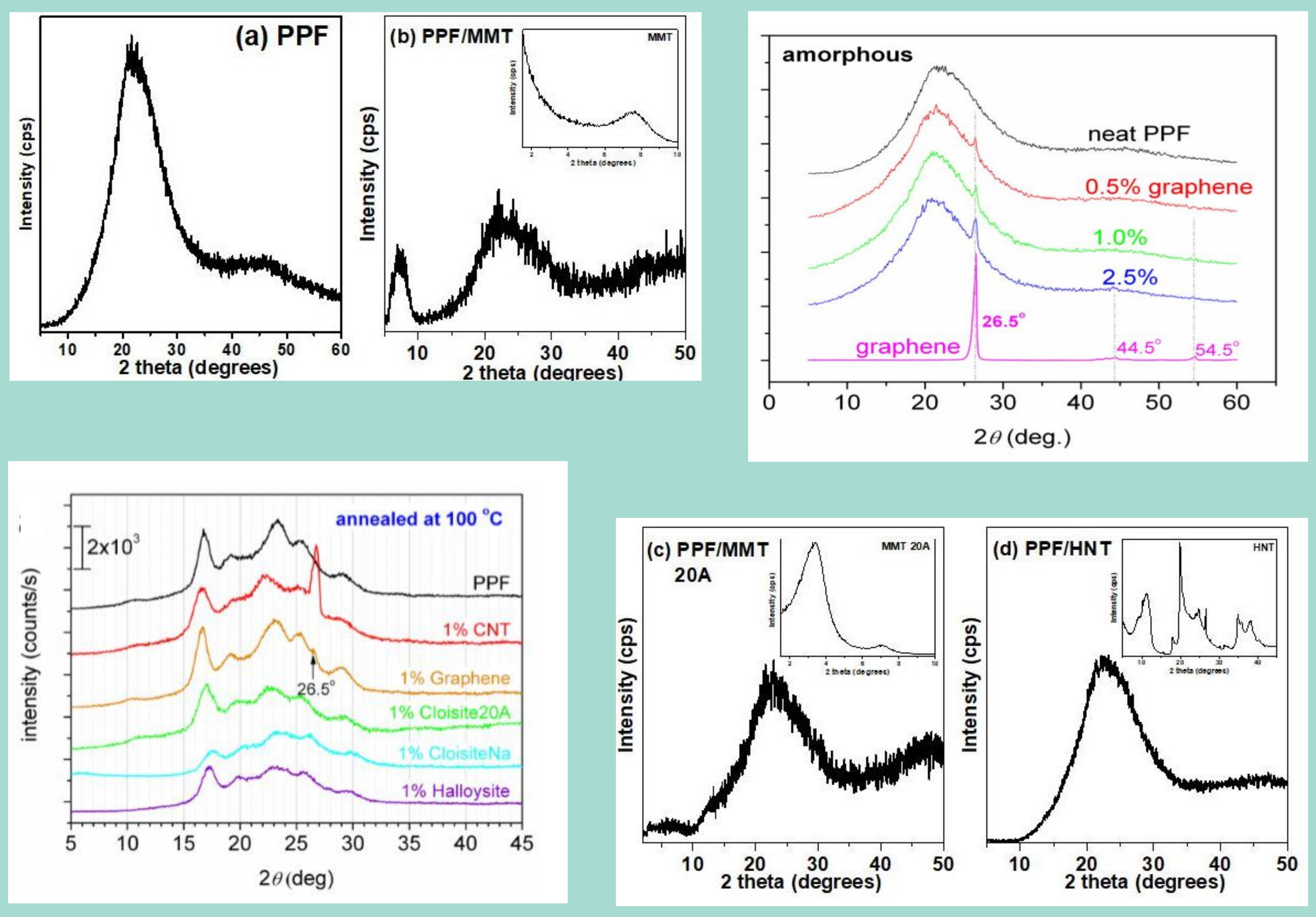
RESULTS

Intrinsic viscosity

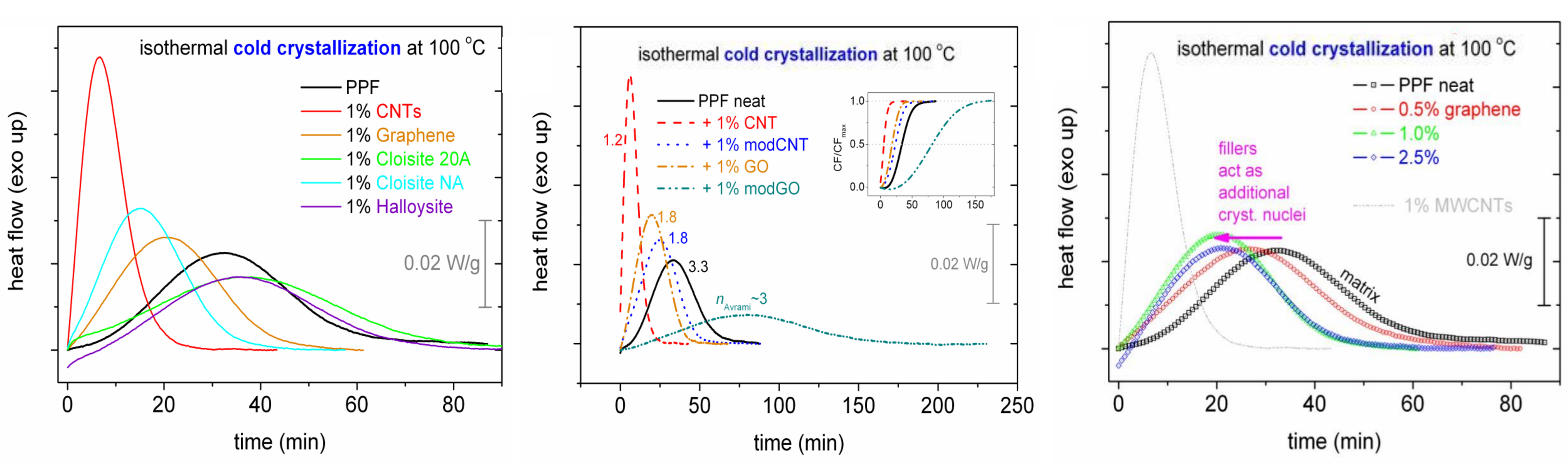
Sample Name	IV
PPF	0.50
PPF MMT Na 1%	0.47
PPF MMT 20A 1%	0.45
PPF HNT 1%	0.41
PPF CNT 1%	0.35
PPF CNT mod 1%	0.42
PPF GO 1%	0.33
PPF GO mod 1%	0.41
PPF Gr 0.5%	0.51
PPF Gr 1%	0.50
PPF Gr 2.5%	0.57

- From the in-situ polymerization method, nanocomposite materials of satisfactory molecular weight can be produced.
- After polymerization, the morphology of the nanoinclusion can be altered from phenomena like intercalation or exfoliation.
- Modification of aluminosilicate clays promotes intercalation of the nanosheets as it shown by the shifting of the peaks at lower angles. With graphene nanoplatelets no such shifting occurs.

X-Ray Diffraction



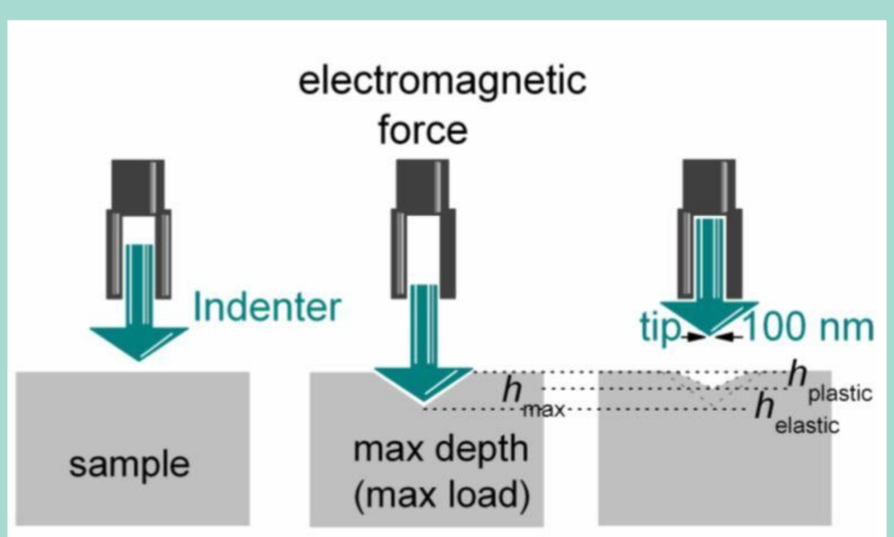
Thermal Properties-Effect on crystallization



- DSC studies showed that the nanofillers in most cases act as additional crystallization nuclei and decrease the time needed for complete crystallization.
- When comparing pristine and modified nanofillers the former have a more distinct effect on the crystallization than the latter.
- Increasing the filler loading in the polymer matrix does not imply a proportionate improvement of crystallization phenomena.

Mechanical Properties Nano-indentation Results

Sample Name	Elastic Modulus (Mpa)
PPF	1261±25
PPF MMT Na 1%	1610±18
PPF MMT 20A 1%	1520±278
PPF HNT 1%	3554±117
PPF CNT 1%	2008±290
PPF Gr 0.5%	1531±154
PPF Gr 1%	2333±100
PPF Gr 2.5%	3915±178



CONCLUSIONS

- In-situ polymerization is the synthetic pathway to be recommended for PPF nanocomposites as it provides satisfactory IV values and good dispersion of the nanoinclusions in the polymer matrix.
- Crystallization of the nanocomposites can be altered to a great extent by utilizing the appropriate nanofiller.
- Nanocomposite materials presented had improved mechanical properties compared to pristine PPF.

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