Mechanical, Thermal, and Flammability Behaviour of Low Density Polyethylene - Oil Based Mud Fillers Nanocomposites

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Introduction

Novel low density polyethylene (LDPE)/Oil based mud fillers (OBMFs) nanocomposites were manufactured by a melt compounding process. A detailed investigation was carried out to identify how the OBMFs which reclaimed from oil based mud waste influence the mechanical, thermal, and flammability properties of this novel nanocomposite material.

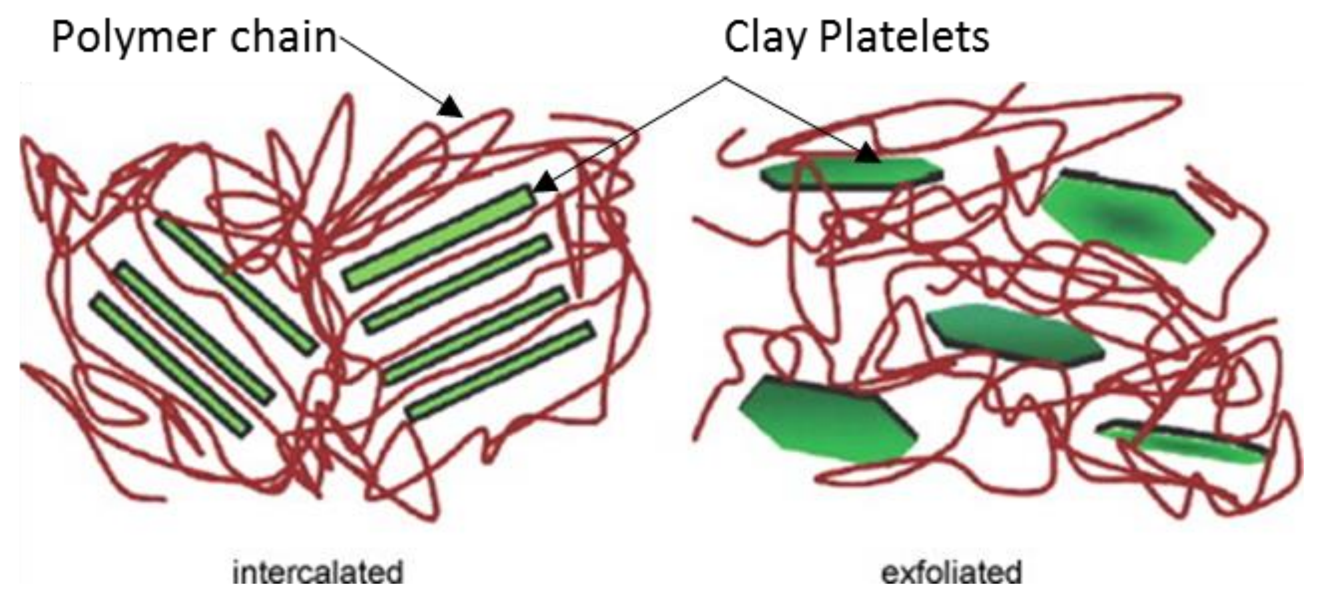

Fig. 1: Schematic illustration of polymer/layered silicate [1]

The surface morphology, crystalline nature, mechanical strength and thermal behaviour of the nanocomposites were characterised by scanning electron microscopy (SEM), X-ray diffraction, tensile and flexural tests, Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA).

Special Features

- Reclaimed clay from oil based drilling fluid waste
- Effect of filler contents on dispersion behaviour
- Improvement in onset thermal degradation temperature
- Tailored manufacturing process based on material application (e.g. thermal conductive material, heat resistant material, material with higher heat capacity)
- Extended self-extinguishing time, after-flame time and flame propagation time indicates the influence of OBMFs in superior flame and fire behaviour
- The presence of platelets does not indicate any significant reduce in mechanical strength

Methodology

Materials and Manufacturing Process

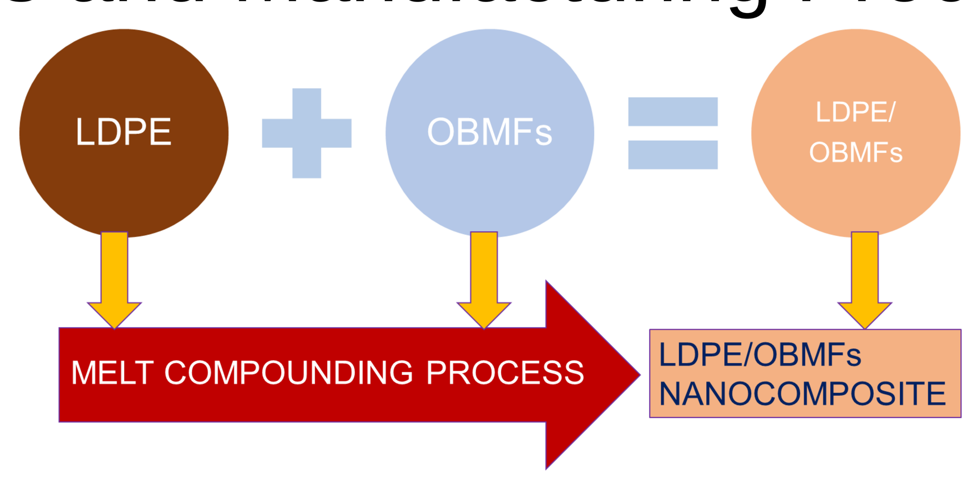

Fig. 2: Nanocomposite fabrication process via extrusion

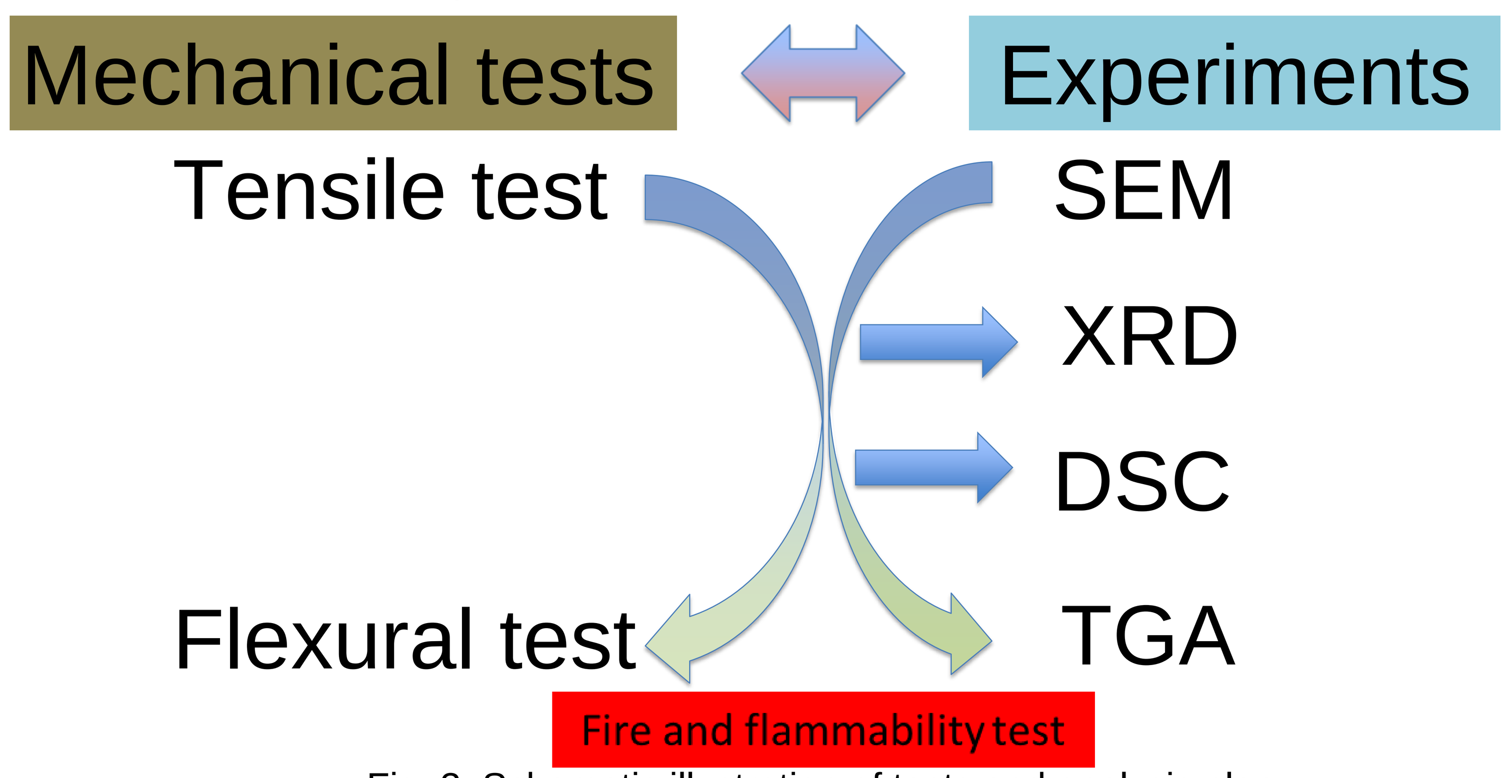

Fig. 3: Schematic illustration of tests and analysis plan

Results

Mechanical tests- Tensile and flexural tests were carried out as part of the mechanical strength investigation of LDPE/OBMFs nanocomposites. Table 1 below shows the effects of OBMFs on tensile and flexural properties of nanocomposites.

Table 1: Mechanical property study of LDPE/OBMFs nanocomposite

Material	Yong's modulus (MPa)	Flexural modulus (Mpa)
Neat LDPE	449	1584
LDPE+2.5 wt% OBMFs	323	1601
LDPE+5.0 wt% OBMFs	288	1532
LDPE+7.5 wt% OBMFs	353	1786
LDPE+10.0 wt% OBMFs	338	1467

Morphology study

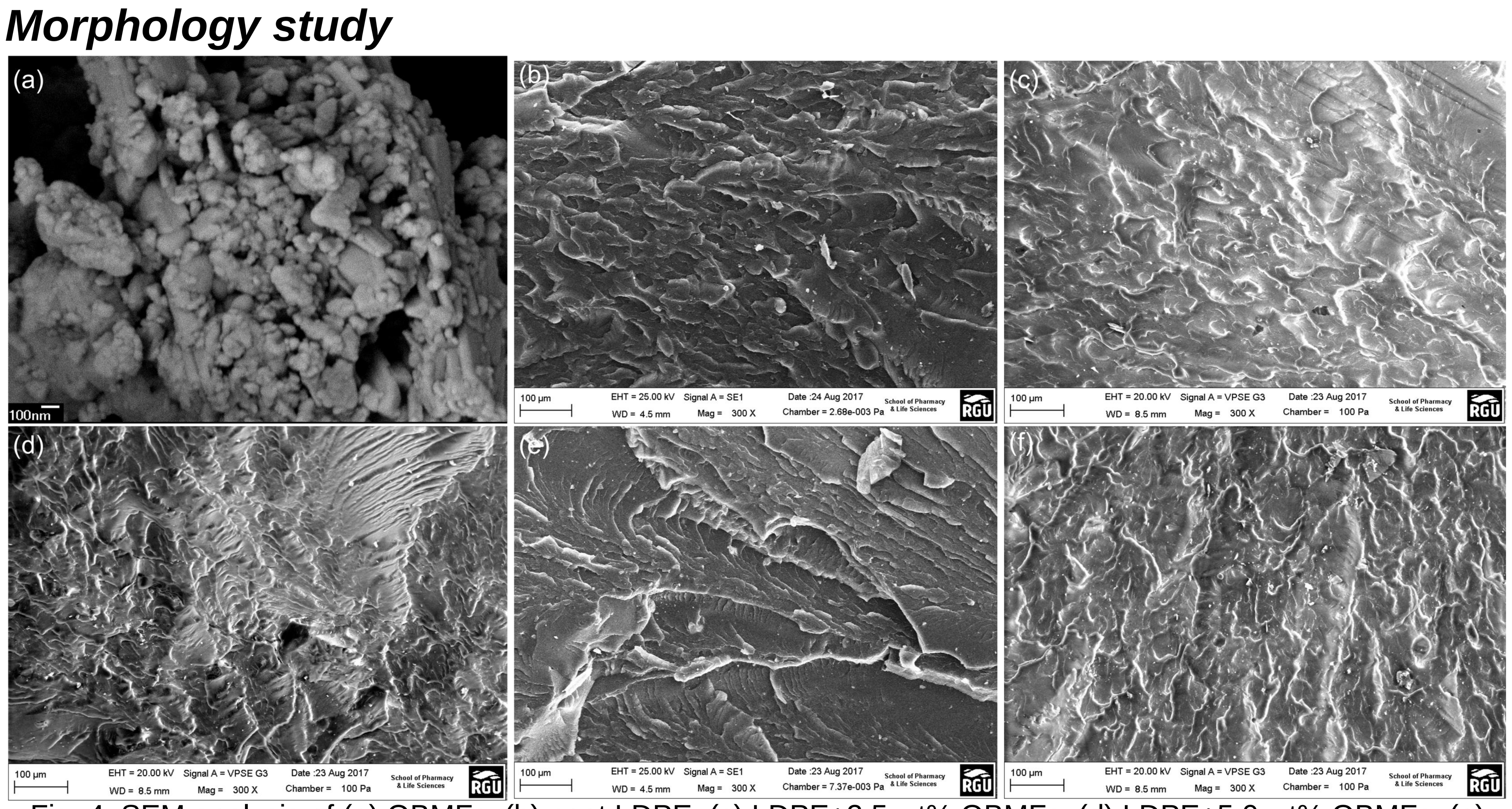

Fig. 4: SEM analysis of (a) OBMFs; (b) neat LDPE; (c) LDPE+2.5 wt% OBMFs; (d) LDPE+5.0 wt% OBMFs; (e) LDPE+7.5 wt% OBMFs and (f) LDPE+10.0 wt% OBMFs nanocomposites.

X-Ray diffraction (XRD) analysis

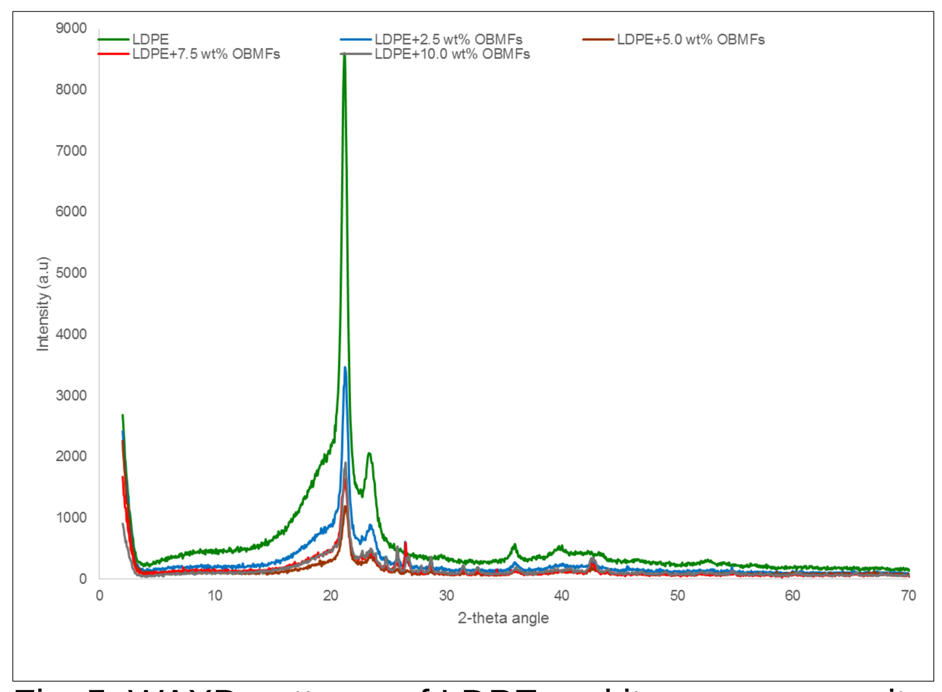

Fig. 5: WAXD patterns of LDPE and its nanocomposites

Thermal analysis

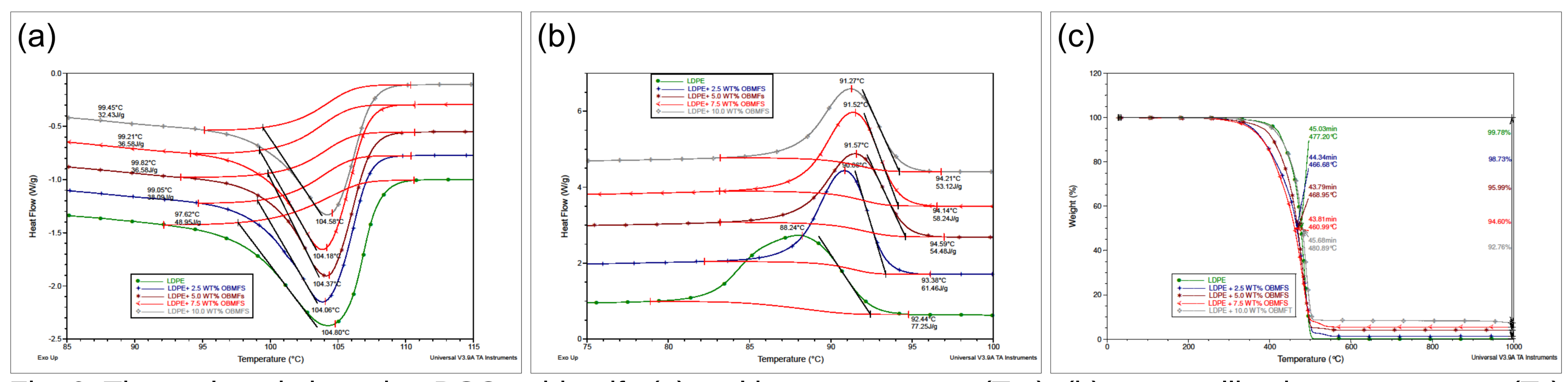

Fig. 6: Thermal study by using DSC to identify (a) melting temperature (Tm); (b) recrystallization temperature (Tc) and (c) TGA study to determine onset degradation at 50% wt loss and residue at 1000°C

Summary

In addition to the results presented above, an intense flame and fire tests have been carried out by following limited oxygen index (L.O.I) and UL 94 method. The findings from the study including flame and fire tests, it can be articulated that OBMFs has a significant influence on thermal stability and flame retardancy property of LDPE/OBMFs nanocomposites.

REFERENCES

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[2] Leszczyńska A Njuguna J Pielichowski K Banerjee J R 2007 *Polymer/montmorillonite nanocomposites with improved thermal properties: Part I. Factors influencing thermal stability and mechanisms of thermal stability improvement.* Thermochimica Acta, Volume 453, Issue 2, Pages 75-96