Using Calcium Carbonate to Alter the Mechanical Properties of Recycled High Density Polyethylene

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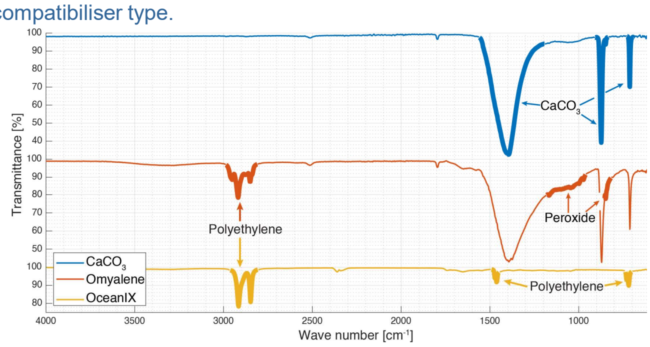
1. Introduction

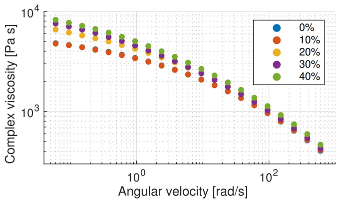
Recycled HDPE tend to have inferior mechanical properties compared to its virgin form. Calcium carbonate can be added, provided compatibilisation can be achieved, to improve its mechanical properties.

A blend with calcium carbonate, binary polyolefin, and compatibiliser was added at varying concentrations to a recycled HDPE branded as OceanIX. The constituents were characterised, while mechanical and thermal tests were performed on the composite to assess its change in properties.

2. Compatibilisation assessment

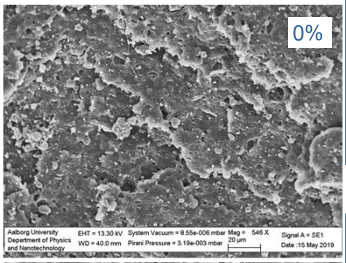
Comparisons between infrared spectra aided the identification of constituents in the calcium carbonate blend. Besides calcium carbonate and polyethylene, peaks of peroxide bonds appeared in the form of shoulders. The presence of peroxides was related to the compatibiliser type.

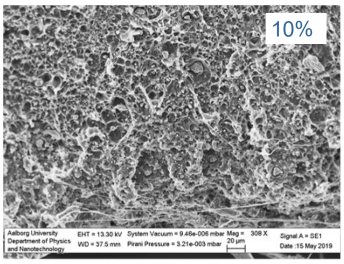


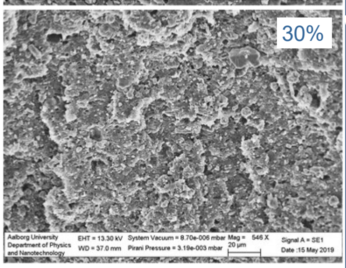


Oscillatory rheology tests suggested weak bonding at the matrix/filler interface as seen by the plateauing of the complex viscosity as angular velocity is decreased.

A sample without filler showed a fracture surface with particle contaminants; probably from the ocean.
The effects of the filler can be seen as specimens with 10% and 20% filler showed ductile fracture behavior evident from the cavities around particles, while 30% and 40% showed brittle fracture.



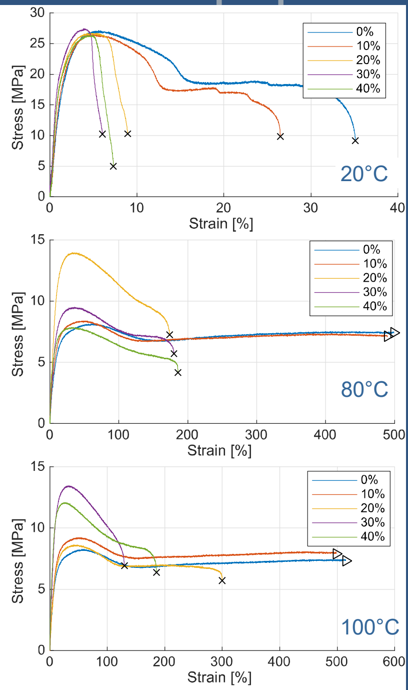


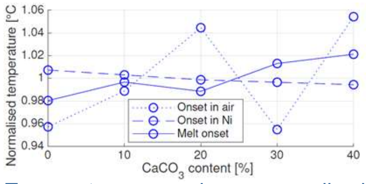


3. Mechanical and thermal properties

Inferences from tensile testing of the composites:

- Filler increased stiffness and decreased ultimate elongation at all temperatures
- Filler did not affect yield stress at 20°C
- Elevated temperatures decreased yield stress and stiffness
- Substantial increase in elongation at elevated temperatures
- High variation in stress-strain curve at elevated temperature.
- Minor deviations in the stress-strain curves between 80°C and 100°C





Temperatures are shown normalized wrt. overall mean temperature. The decomposition onset for samples without filler in air was 395°C and 469°C for nitrogen. The melt onset temperature in air was 120°C.

Filler increased the decomposition temperature in air, attributed to the presence of additional chemical bonds created by the compatibiliser. No substantial change was seen for decomposition in a nitrogen atmosphere.
Minor increases in melt onset in air was seen.

4. Conclusions

- The compatibilizer in the supplied filler blend was found to contain a peroxide group. However, rheology measurements showed that the matrix/filler bonding was weak.
- It was found, the filler acted as thermal stabiliser, increasing decomposition and melt onset temperature in an atmosphere of air.
- Increased stiffness and decreased ultimate elongation was seen with increased filler content for 20°C, 80°C, and 100°C.

Acknowledgement

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