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A Comparative Study of Polyolefin-Based and Biodegradable Composites containing metal hydroxides

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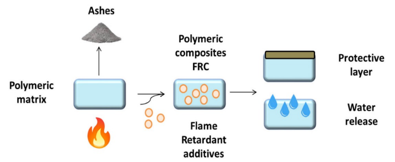
INTRODUCTION & AIM

The present work proposes the use of metal hydroxides, specifically aluminium and magnesium hydroxides, as halogen-free flame-retardant additives in polymer matrices. The present study focuses on comparing their performance in polyolefin-based polymers and bio-polymer composite formulations. This approach is motivated by sustainability considerations and the growing market demand for environmentally friendly flame-retardant materials.



$Me(OH)_x \rightarrow MeO_y + {}_zH_2O$

METHOD

Metal hydroxides were incorporated into two different polymer matrices:
- EVA/LLDPE blend
- PBS matrix

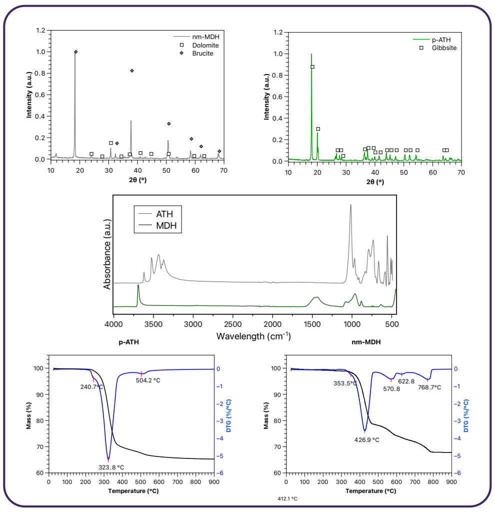
Two types of metal hydroxides were evaluated for flame-retardant composites (FRCs):
- Precipitated aluminium hydroxide (p-ATH)
- Naturally milled magnesium hydroxide (nm-MDH)

Characterization of metal hydroxides included:
- X-ray powder diffraction (XRD)
- Thermogravimetric analysis (TGA)
- Morphological observation SEM
- Spectroscopic methods ATR-FT-IR

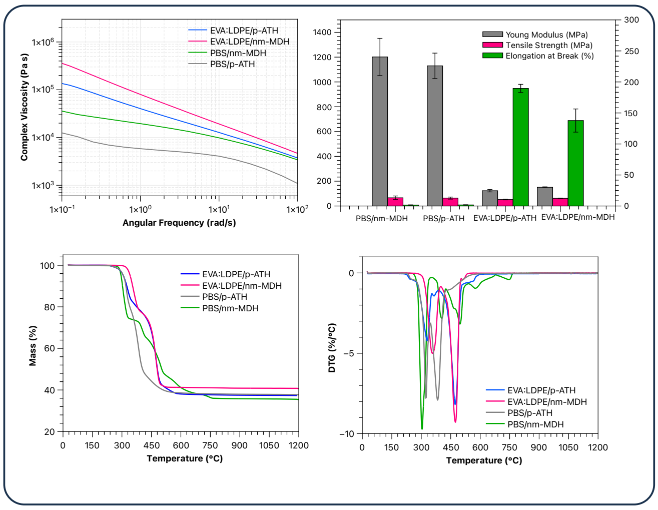
Characterization of FRCs included:
- Thermal analysis TGA, DSC
- Rheological characterization
- Morphological observation SEM
- Spectroscopic methods ATR-FT-IR
- Mechanical characterization (Tensile and DMTA)
- Cone Calorimeter

RESULTS & DISCUSSION

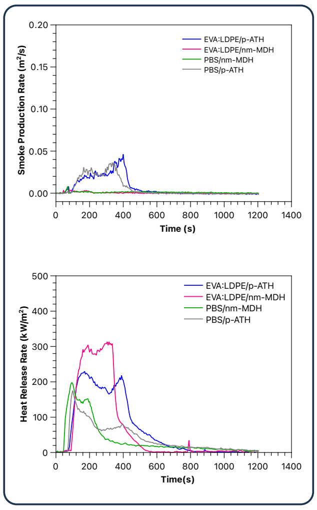
Particles Characterization



Composites Characterization



Cone Calorimeter Test



CONCLUSION

- p-ATH and p-MDH consist mainly of gibbsite and brucite, respectively.
- nm-MDH contains brucite with minor dolomite impurities, whose carbonates improve flame retardancy due to their higher decomposition temperatures.

- PBS MDH shows the highest viscosity, indicating stronger filler–matrix interactions than PBS ATH, while EVA:LDPE/p-ATH and EVA:LDPE/nm-MDH display higher viscosity trends, with p-MDH acting as a reinforcing agent through interactions between MA-g-LLDPE and $Mg(OH)_2$, forming 3D structures.
- It is worth considering the replacement of an EVA:LDPE matrix with PBS, as the thermal stability appears promising. The residue at 1200 °C of the composites is comparable, and the material retains 100% of its mass up to at least 270 °C, suggesting this option deserves further investigation.
- The mechanical properties exhibit very different behaviors; when replacing EVA:LDPE with PBS, we have significantly reduced the Young's modulus, while observing a strong increase in tensile strength. Nevertheless, the overall ductility and elongation at break remain comparable, considering that 60 wt.% consists of hydBy replacing EVA:LDPE with PBS, we observe excellent flame-retardant behavior, with the heat release rate showing a much lower curve for PBS and a complete reduction in the smoke production rate.roxide particles.

By replacing EVA:LDPE with PBS, we observe excellent flame-retardant behavior, with the heat release rate showing a much lower curve for PBS and a complete reduction in the smoke production rate; however, the ignition time for PBS-based composites is reduced.

FUTURE WORK / REFERENCES

M. Maqsood, G. Seide, Biodegradable Flame Retardants for Biodegradable Polymer, Biomolecules 10 (2020) 1038. https://doi.org/10.3390/biom10071038.

L. Gopal, T. Sudarshan, Non Halogenated Flame Retardants, Surface Engineering 40 (2024) 929–932. https://doi.org/10.1177/02670844241296887.

A. Viretto, R. Sonnier, A. Taguet, B. Otazaghine, L. Ferry, J. Lopez-Cuesta, C. Lagrève, Thermal degradation of polyesters filled with magnesium dihydroxide and magnesium oxide, Fire and Materials 40 (2016) 445–463. https://doi.org/10.1002/fam.2299.

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