cbecimat26
26° Congresso Brasileiro de Engenharia e Ciência dos Materiais
22 a 26 de novembro de 2026
Costão do Santinho
Florianópolis-SC

INTERFACIAL AND MECHANICAL EVALUATION OF SUSTAINABLE HDPE COMPOSITES

Effect of ionomer waste as compatibilizer and processing route

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Introduction

Coir is a renewable reinforcement for HDPE. The polarity mismatch between the fiber and the matrix limits adhesion and stress transfer. Ionomer production waste offers a route to improve the interface while reusing a residue.

Objectives

Evaluate 6 wt% ionomer waste against 3 wt% commercial E/MA in HDPE with 30 wt% coir. For the ionomer composite, compare direct injection molding with extrusion followed by injection molding.

Experimental

HDPE IB58, untreated coir, Surlyn® PC2000 sodium ionomer waste and Fusabond® M603 (E/MA).

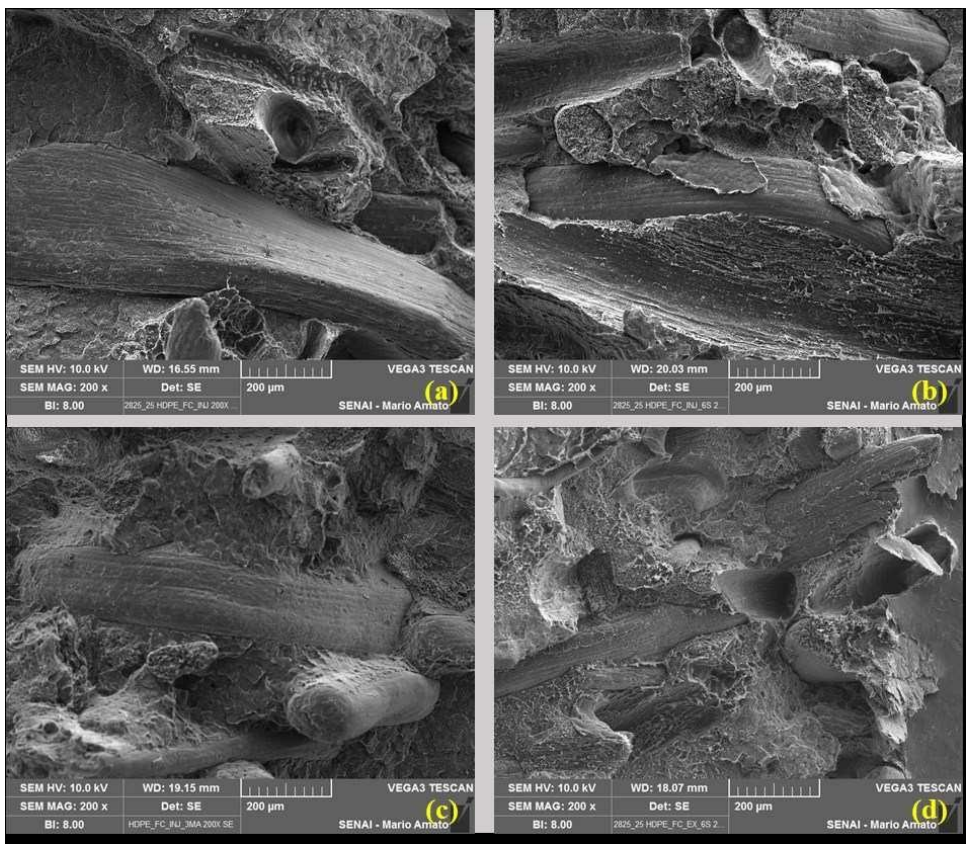
Nominal compositions (wt%)

Code	HDPE	Coir	Ionomer	E/MA	Route
H	100	0	0	0	INJ
H-S	94	0	6	0	INJ
H-F	70	30	0	0	INJ
H-F-S	64	30	6	0	INJ
H-F-M	67	30	0	3	INJ
H-F-S-E	64	30	6	0	EX + INJ

INJ = direct injection molding EX + INJ = extrusion followed by injection molding

Tensile (ASTM D638), flexural (ASTM D790) and notched Charpy (ASTM D6110) tests. Fracture surfaces were examined by SEM. Fiber length was measured after dissolving the matrix in hot xylene.

Interfacial Morphology



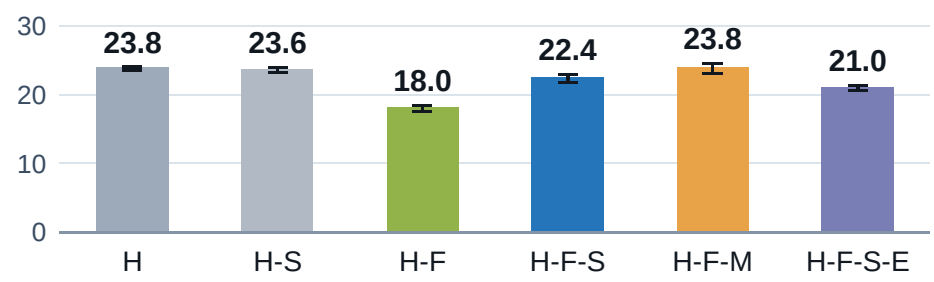
SEM at 200×. (a) H-F, (b) H-F-S, (c) H-F-M and (d) H-F-S-E. Scale bars = 200 µm.

H-F showed exposed fibers, gaps and pull-out cavities. The ionomer formulations showed partial adhesion. E/MA gave more extensive polymer coverage of the fibers.

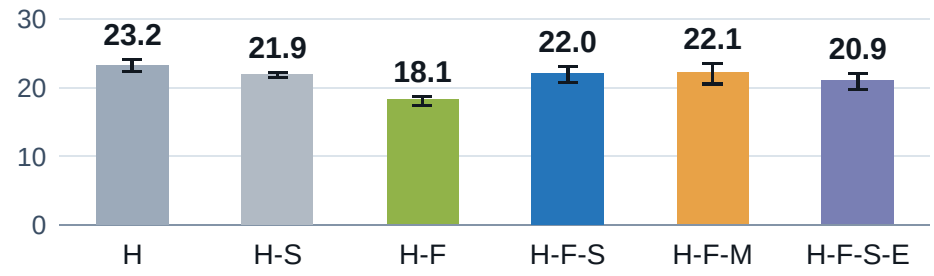
Results and Discussion

Means ± standard deviations. Pairwise ANOVA, α = 0.05.

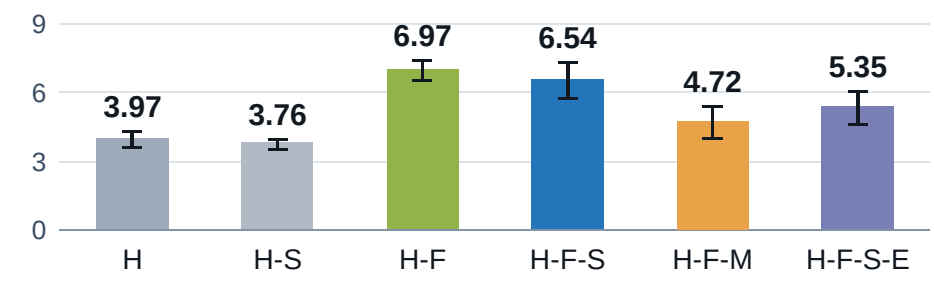
Tensile strength (MPa)



Flexural stress at 5% strain (MPa)



Notched Charpy impact strength (kJ/m²)



Effect of ionomer waste

Relative to H-F, H-F-S increased tensile strength by 24.5%, tensile modulus by 15.9% and flexural stress by 21.5%. The difference in Charpy impact strength was not significant ($p = 0.164$).

Effect of prior extrusion on H-F-S

Mean fiber length 1.87 → 1.10 mm (−41%)

Extrusion before injection molding reduced tensile strength by 6.5% and Charpy impact strength by 18.3%.

Conclusions

- Ionomer waste improved interfacial contact, tensile strength and flexural stress at 5% strain relative to H-F.
- E/MA gave higher tensile strength. The ionomer composite retained higher Charpy impact strength.
- Direct injection molding preserved longer fibers and gave higher tensile and impact strengths for the ionomer composite.

References

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Acknowledgments

Centro Universitário FEI, CAPES-PROAP and CNPq for support. Silgan Dispensing for supplying the ionomer waste.