Supplementary Materials

Table S1 Lossless Separation of Tetra Pak Carton Components using Formic Acid.

Run	Materials	Before treatment	After treatment	Difference
1	Paper	0.0107	0.0101	0.00
	Aluminum	0.0046	0.0047	0.00
	Polyethylene	0.0186	0.0183	0.00
2	Paper	0.0112	0.0109	0.00
	Aluminum	0.0038	0.0035	0.00
	Polyethylene	0.0103	0.0098	0.00

Supplementary Table S1 shows the results of lossless separation of the main components of Tetra Pak cartons using formic acid. The table documents the mass of paper, aluminum, and polyethylene before and after treatment with formic acid over two experimental runs. As detailed in the accompanying text, impurities in the composite material could not be effectively removed by leaching alone due to the polyethylene barrier protecting the layers. Formic acid was carefully selected as a solvent that could separate the polyethylene without material loss at a temperature below its boiling point. To minimize losses during separation, each component was processed individually under optimized conditions. The experiment was performed twice to verify consistency, and observed differences between runs were negligible as seen in Supplementary Table S1.

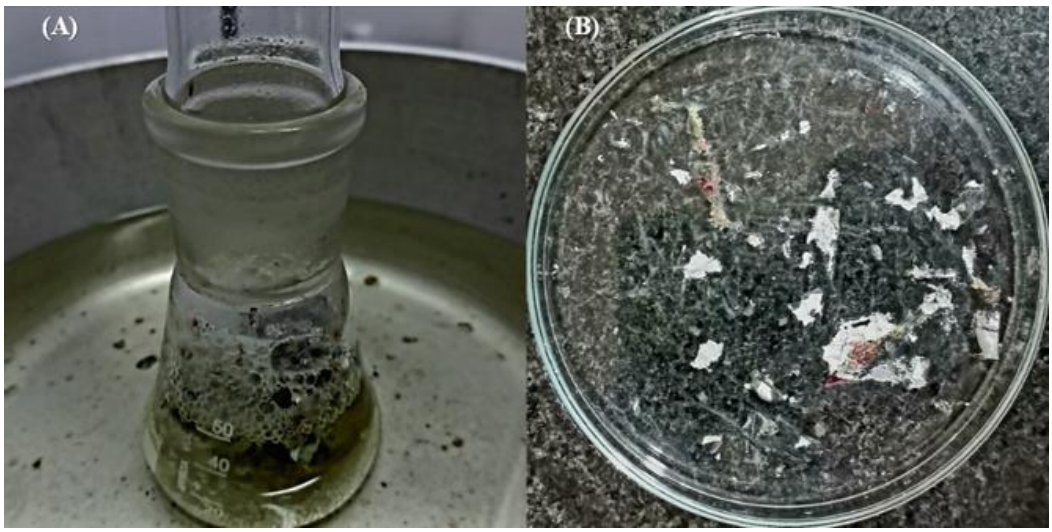

Fig. S1 (A) Foam formation during processing and (B) Polyethylene adhesion after drying.

Supplementary Figure S1 shows foam formation during processing (A) and polyethylene adhesion after drying (B). Figure A illustrates the foaming that occurred when water was included in the solvent mixture. Foam formation was problematic because it caused some aluminum and

paper components to float and adhere to equipment. Figure B shows polyethylene adhering to labware after drying, which happened when dissolution was incomplete in the solvent.

Table S2 Percent polyethylene dissolution for additional gasoline samples to demonstrate repeatability.

Run	Before treatment	After treatment	Percent change	Percent dissolution
	Mass (g)	Mass (g)	Mass (%)	Mass (%)
Gasoline (1)	1.0032	0.3694	63.2	84
Gasoline (2)	1.0011	0.3356	66.5	89

Supplementary Table S2 shows the repeatable dissolution of polyethylene using gasoline solvents. Two gasoline samples were tested for their effectiveness in dissolving polyethylene from composite materials. The table documents the mass of polyethylene before and after treatment with the gasoline solvents over two experimental runs. Gasoline (1) achieved 84% polyethylene dissolution, while Gasoline (2) achieved 89% dissolution. The consistent results in the 80-90% range demonstrate the repeatability of using gasoline as an effective solvent for dissolving the polyethylene fraction from Al-PE composites.