Recovery/Recycling/Reuse of fiber-reinforced thermoplastic composites deriving from end-of-life battery cases. An experimental study.

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A. Fringuellucci (1), N. Corsaro (2), U. De Angelis (2), S. Pucciarmati (2), S. Sau (2), A. Spadoni (2), R. Tuffi (2), M. Pentimalli (2)

(1) DICAM, Alma Mater Studiorum, Via Umberto Terracini 28, Bologna, 40131, Italy (2) ENEA – Italian National Agency for Energy, New Technologies and Sustainable Economic Development, Casaccia Research Centre, via Anguillarese 301, 00123 Rome, Italy

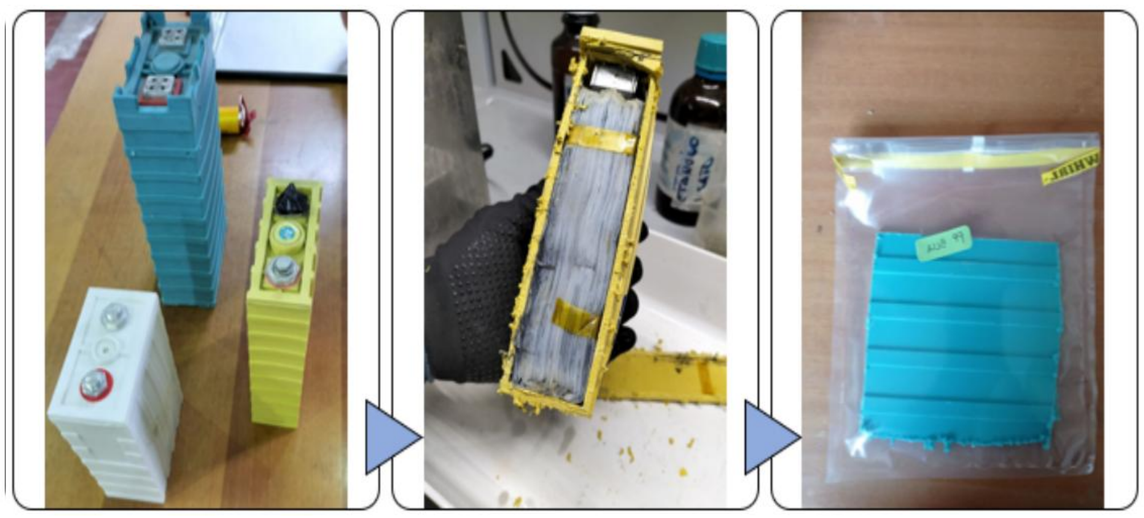
AIM

In order to promote the development of advantageous processes in terms of energy and environmental sustainability, here we test a methodology for the recovery and recycling of plastic hcases from exhausted lithium batteries.

APPROACH

1. Plastic cases were recovered by disassembling some available lithium batteries
2. A reverse engineering approach was used to determine the chemical-physical features of the plastic material constituting the cases (not available from the producer)
3. The materials' properties were compared with those of similar thermoplastic composites selected as reference materials and treated by a combination of mechanical grinding and extrusion processes

1. RECOVERY

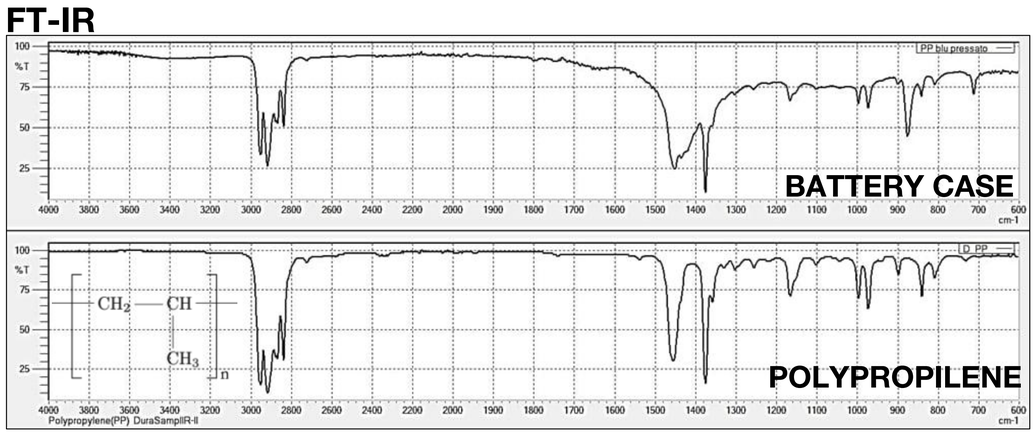


Small size Lithium batteries — Disassembly — 10x10 cm samples

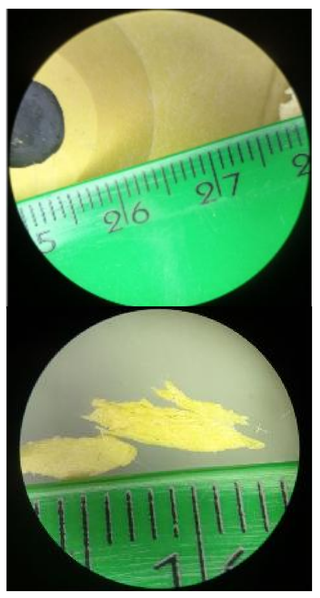
- The exhausted batteries were discharged according to a conventional protocol.
- The electrodes were short circuited and the batteries opened under proper security conditions
- The plastic cases were separated from the system, reduced in sample parts, cleaned

2. CHEMICAL-PHYSICAL CHARACTERIZATION

FT-IR

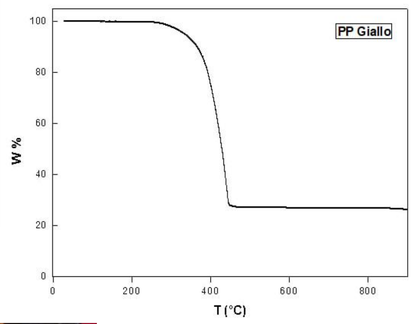


MORPHOLOGY



GLASS FIBER Reinforced POLYPROPILENE

TGA



~25% GLASS FIBER filler

3. RECYCLING

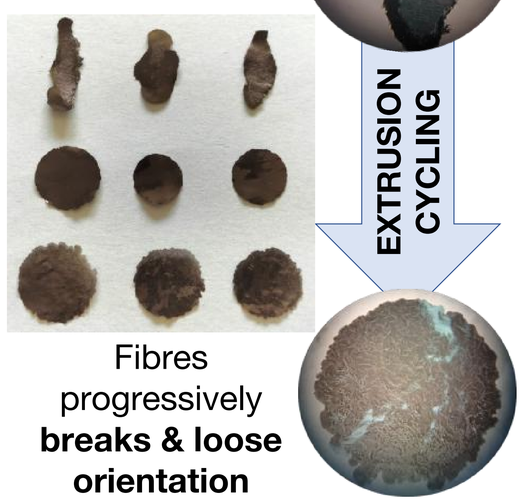
COMMERCIAL REFERENCE SAMPLE
Polypropylene + 25% glass fibres

AGEING BY REAPETED EXTRUSION CYCLING

REOLOGY

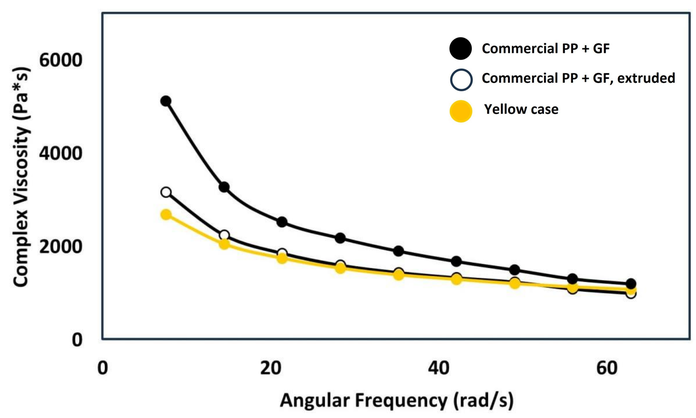
type	sample names	Melt Flow Index 2.16 kg/2h at 210°C (g/10 min)
Plastic cases PP + glass fibre	White	4
	Yellow	5
	Blue	12
Commercial PP + glass fibre	As received	4
	Extruded (1 cycle)	7
	Extruded (2 cycles)	12
Commercial Polypropylene	high viscosity	25
	medium viscosity	53
	low viscosity	100

MORFOLOGY



Fibres progressively **breaks & loose orientation** under extrusion cycling

Commercial PP+ glass fibre is effectively aged by extrusion with an expected **increase of the MFI & decrease in viscosity**



CONCLUSIONS

Different cases recovered from small-size lithium batteries at their end of life were assessed to be constituted by a **thermoplastic composite of polypropilene reinforced by 25% w/w of glass fibre**. Similar commercial composite was selected as **reference material** and **agead by repeated extrusion cycling**. The composite processed in this way presents only a slight reduction in its reological properties pointing to a quite good retainment of mechanical properties too (work is in progress). This realistically implies a good possibility of reusing the recovered materials for specific applications of similar mechanical resistance and -prudentially- less stringent requirements in terms of safety of use compared to those specific for batteries.