MATE.RIA

Metodi e **A**zioni per il **T**rattamento **E**cologico dei **TE**ssili post-consumo
e il loro **R**iciclo **I**nnovativo in **A**rchitettura

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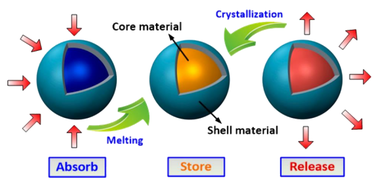
GOAL & CONCEPT

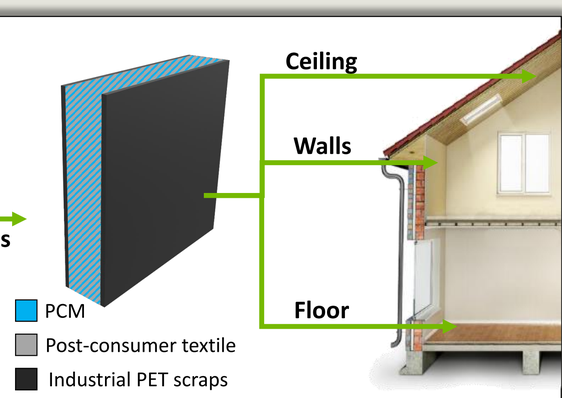
Upcycle

Life extension for post-consumer garment textiles and identification of new market for polyethylene terephthalate (PET) waste produced during fiber production

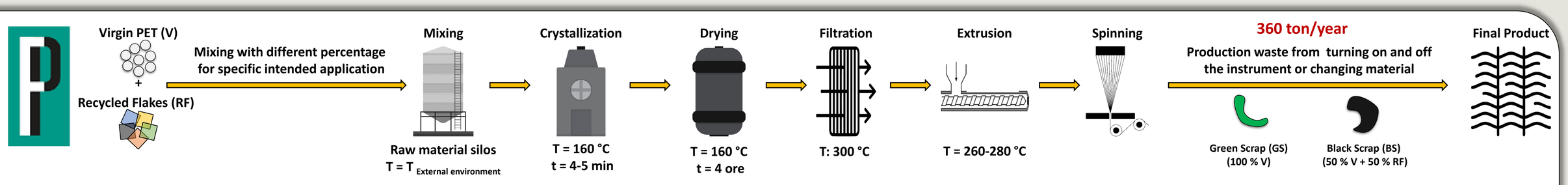
Industrial PET Scraps from *Frana Polifibre* + **Post-consumer textile waste from *HUMANA*** + **Phase Change Materials (PCMs)**



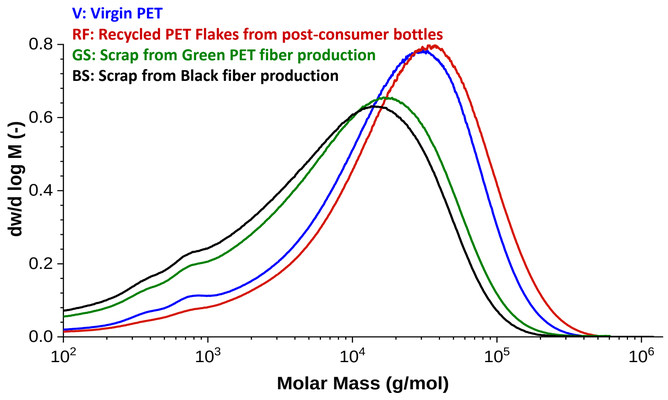
Design of a product for architectural applications



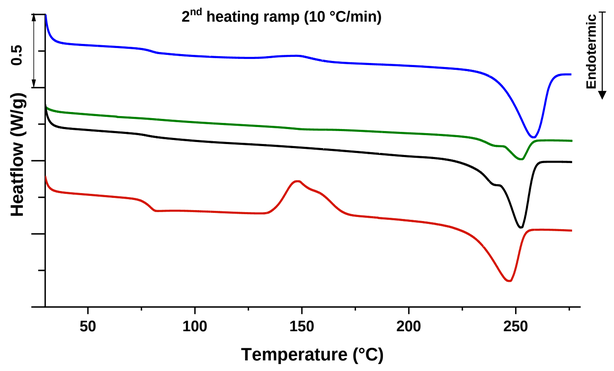
PET CHARACTERIZATION



Structural

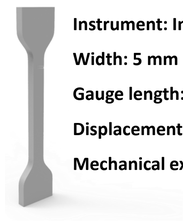


Thermal

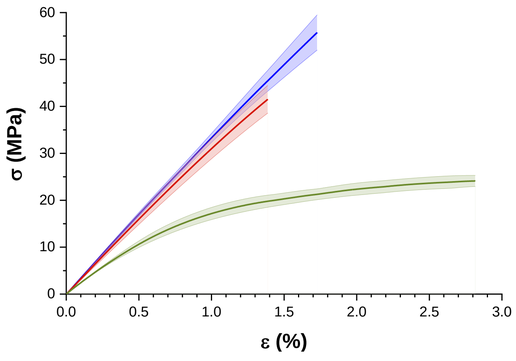


Mechanical

Specimen preparation:
PET plates by compression molding
5 min, 270 ± 3 °C, 86.3 kPa →
5 min, 270 ± 3 °C, 222 kPa →
Cooling at 5 °C /min to 20 °C



Instrument: Instron 5967
Width: 5 mm
Gauge length: 25 mm
Displacement velocity: 0.5 mm/min
Mechanical extensometer (L_0 =12 mm)



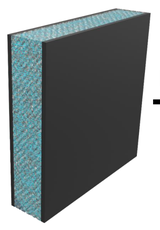
Properties	Structural Properties			Thermal Properties			Mechanical Properties			
Material	M_n (g/mol)	M_w (g/mol)	Polydispersity Đ [-]	Glass transition T_g (°C)	Melting point T_m (°C)	Crystallinity χ_c (%)	Elastic Modulus (GPa)	Deformation at break (%)	Stress at break (MPa)	Energy at break (J/m³)
V: Virgin PET	2.07×10^4	3.2×10^4	1.54	79.5 ± 0	258.0 ± 0.2	29.21 ± 1.31	3.4 ± 0.1	1.1 ± 0.4	36.2 ±11.6	$(2.2 \pm 1.5) \times 10^5$
RF: Recycled PET Flakes from post-consumer bottles	2.41×10^4	4.06×10^4	1.68	78.2 ± 0.3	246.7 ± 0.2	10.87 ± 7.07	3.2 ± 0.2	1.6 ± 0.9	43.5 ± 16.4	$(4.2 \pm 3.6) \times 10^5$
GS: Scrap from Green PET fiber production (100% V + pigment)	6.41×10^3	1.92×10^4	3.00	80.7 ± 1.7	253.2 ± 1.1	19.33 ± 0.47	2.1 ± 0.4	0.6 ± 0.2	19.4 ± 5.6	$(5.7 \pm 3.3) \times 10^4$
BS: Scrap from Black fiber production (50% V+ 50% RF + pigment)	3.8×10^3	1.55×10^4	4.08	80.3 ± 3.0	252.0 ± 0.3	28.59 ± 0.80	ND	ND	ND	ND

Structural Characterization:
During the manufacturing process:
- ✓ The average molecular weight of the material decreases by 40 percent
- ✓ The polydispersity of the material doubles
- ✓ The material cannot be used within the company's operating system

Thermal Characterization:
- ✓ Both PET Scraps behave as virgin PET, well crystallizing during cooling while recycled PET flakes (RF) has a low crystallinity degree
- ✓ The melting temperature (T_m) of the PET scraps are between virgin PET and recycled PET

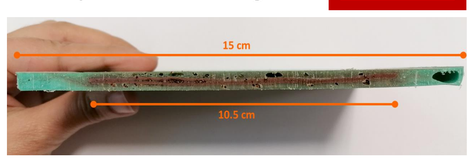
Mechanical Characterization :
- ✓ Elongation at break varies in the range of 0.6 -1.6 %
- ✓ As expected, the material is not suitable for the development of products with compression molding
- ✓ Due to the presence of Carbon Black as pigment in BS, the material was highly fragile it was not possible to obtain specimens for mechanical characterization (ND in the Table)

COMPOSITE PANEL DEVELOPMENT



Preliminary attempts

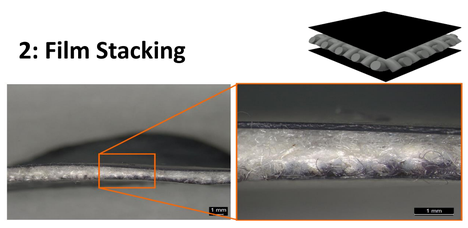
1: Compression Molding



CONS

The textile degrades at temperature of 270 °C, adopted PET compression molding

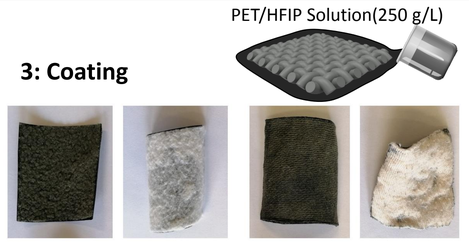
2: Film Stacking



Different Weaving patterns are responsible of distortion observed

3: Coating

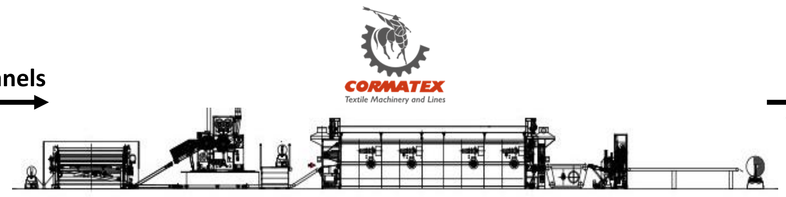
PET/HFIP Solution(250 g/L)



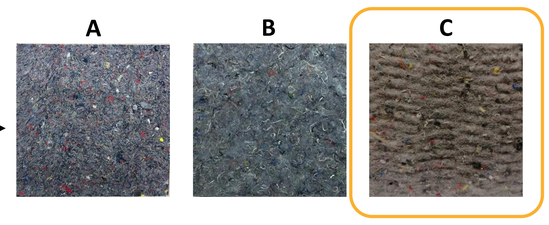
Outcomes
- ✓ Compression molding of PET and textiles is not suitable
- ✓ A homogeneous non-woven structure for the textile is crucial
- ✓ Higher thickness (5-8 cm) for building insulation application is proper

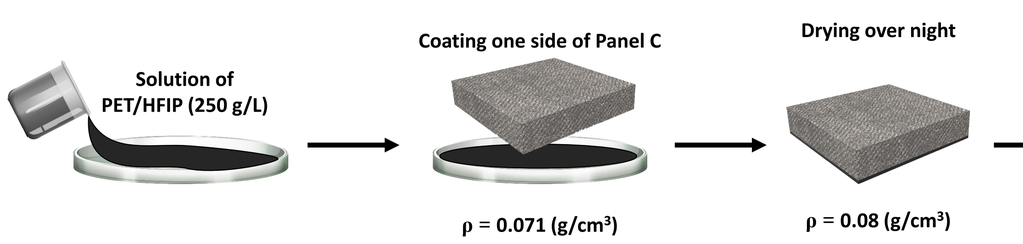
Converting garments to staple

Converting staples to panels
Airlay Technology



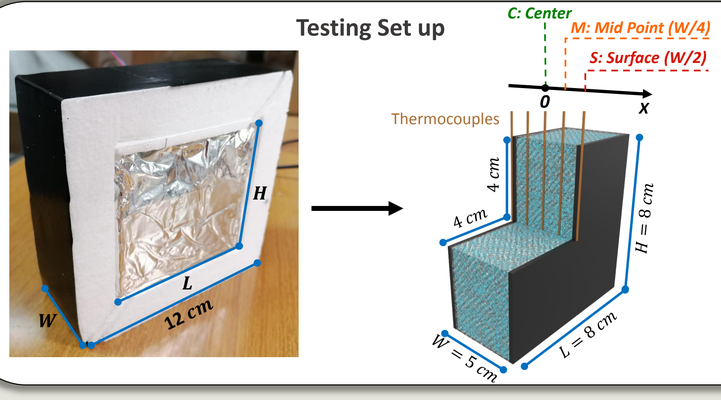
Non-woven Textile panels



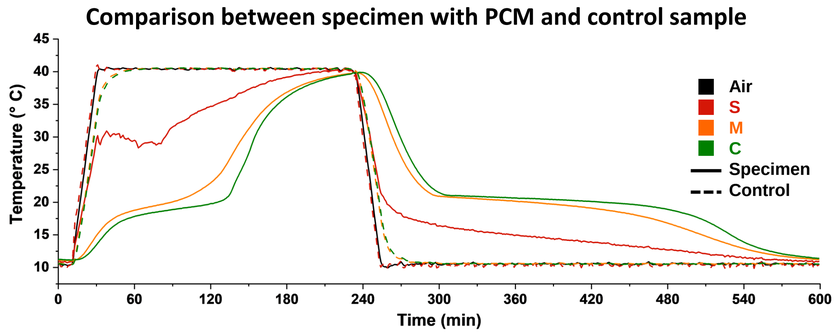


FIRST RESULTS

Testing Set up

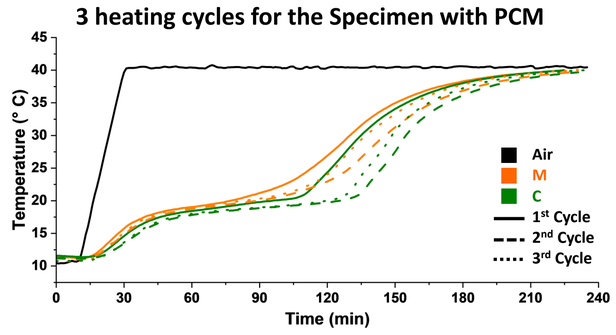


Comparison between specimen with PCM and control sample



Specimen with PCM keeps the temperature at 20 °C for longer time

3 heating cycles for the Specimen with PCM



The response of specimen with PCM is riproducibile

Acknowledgments
This project is financed by the Ministero dell'ambiente e della sicurezza energetica-MITE (MATE.RIA_2022_D33B22000030004)

FRANAPOLIFIBRE · HUMANA PICCOLI GESTI CHE TRASFORMANO IL MONDO · CENTROCOT Innovation experience · CORMATEX Textile Machinery and Lines

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