



Steel corrosion protection using post-consumer polyethylene terephthalate coatings

E. Silva, F. Cotting, V. Lins

*Department of Chemical Engineering, University of Minas Gerais,
Belo Horizonte, Brazil*

M. Fedel*, F. Deflorian

*Department of Industrial Engineering, University of Trento,
Trento, Italy*

**michele.fedel@unitn.it*

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Poly Ethylene Terephthalate (PET)

PET is a widely used form of plastics in food packaging industry to make bottles of

- ✓ Mineral water
- ✓ Soft drink
- ✓ Ketchup
- ✓ Pickle
- ✓ etc.



ATTENTION!

PET packaging generates waste! Environmental issues related to

- ✓ Release of microplastics
- ✓ Disposal problems
- ✓ Drains blockage
- ✓ Flooding

Recycled Poly Ethylene Terephthalate (rPET)

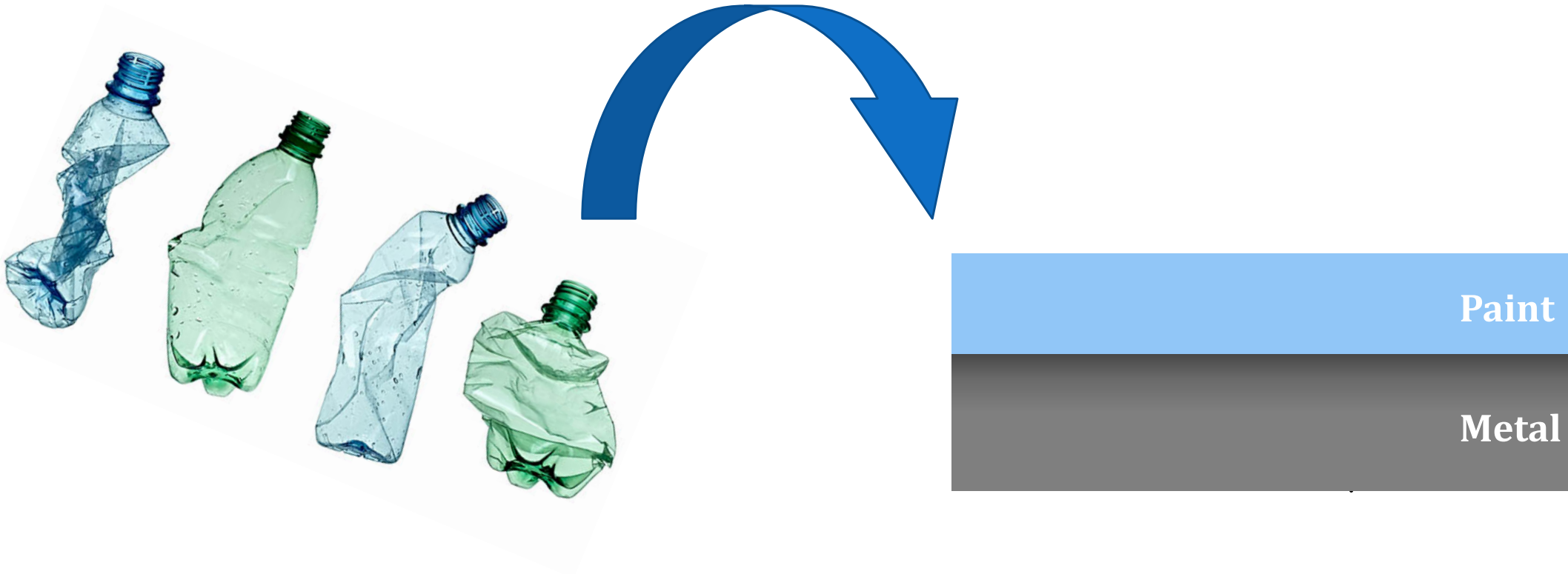


GVM study, commissioned by the Forum PET in the IK Industrievereinigung Kunststoffverpackungen e.V (2015)



Market analysis carried out by GVM, the Gesellschaft für Verpackungsmarktforschung, for the year 2013

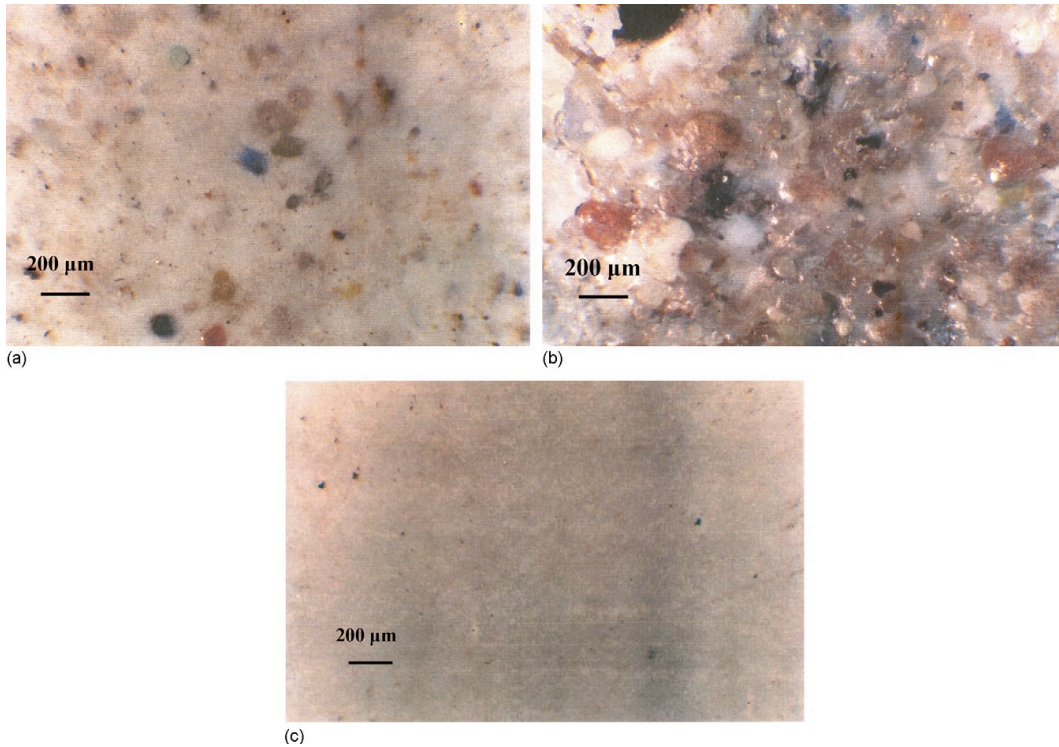
rPET as material for polyester based coatings



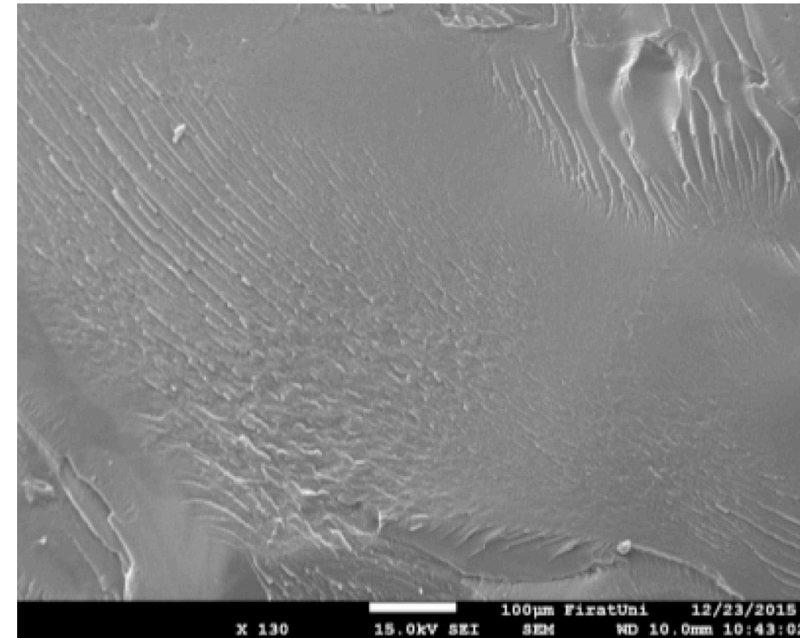
AIM of the project: assess the potential of post consumer PET bottles as a material for polyester based paint for corrosion protection of steel

Recycled plastics derived coatings

rPE, rPET, rPS, rPVC coatings by thermal spray



rPET+marble dust coatings by extrusion



rPET as material for polyester based coatings

Phase 1

- Solvent dissolution
- Liquid application

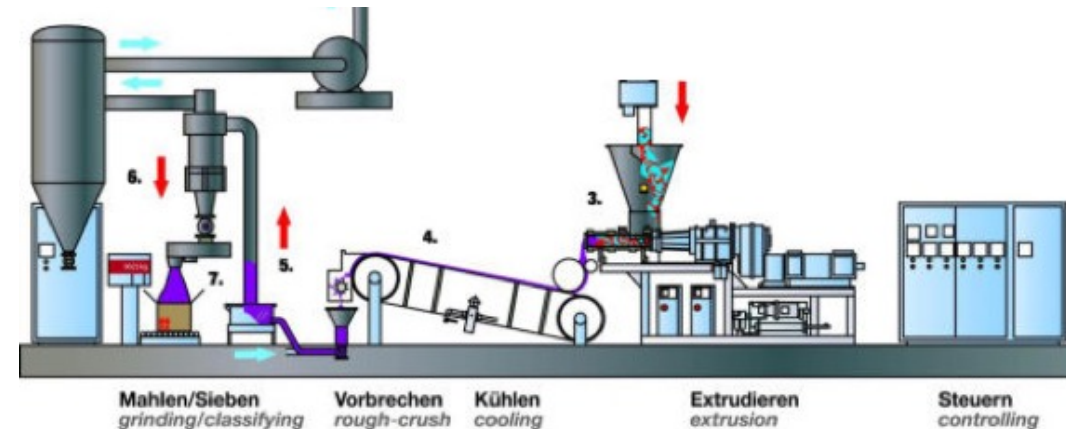
Phase 2

- Shredding
- Sintering

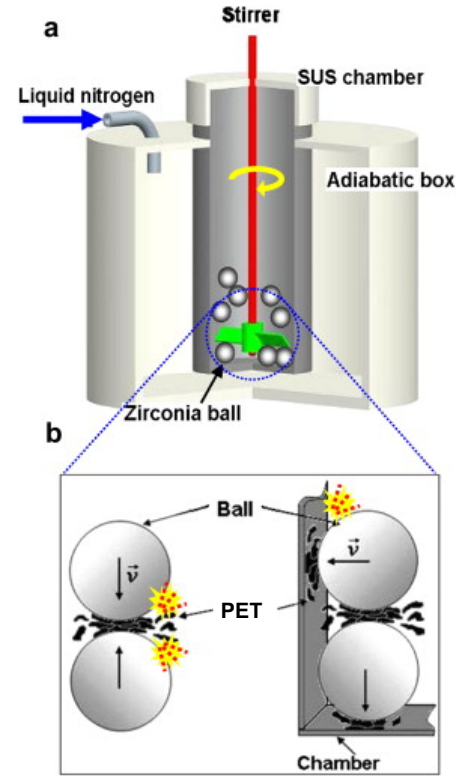
Phase 3

- Shredding
- Extrusion
- Milling
- Powder coating

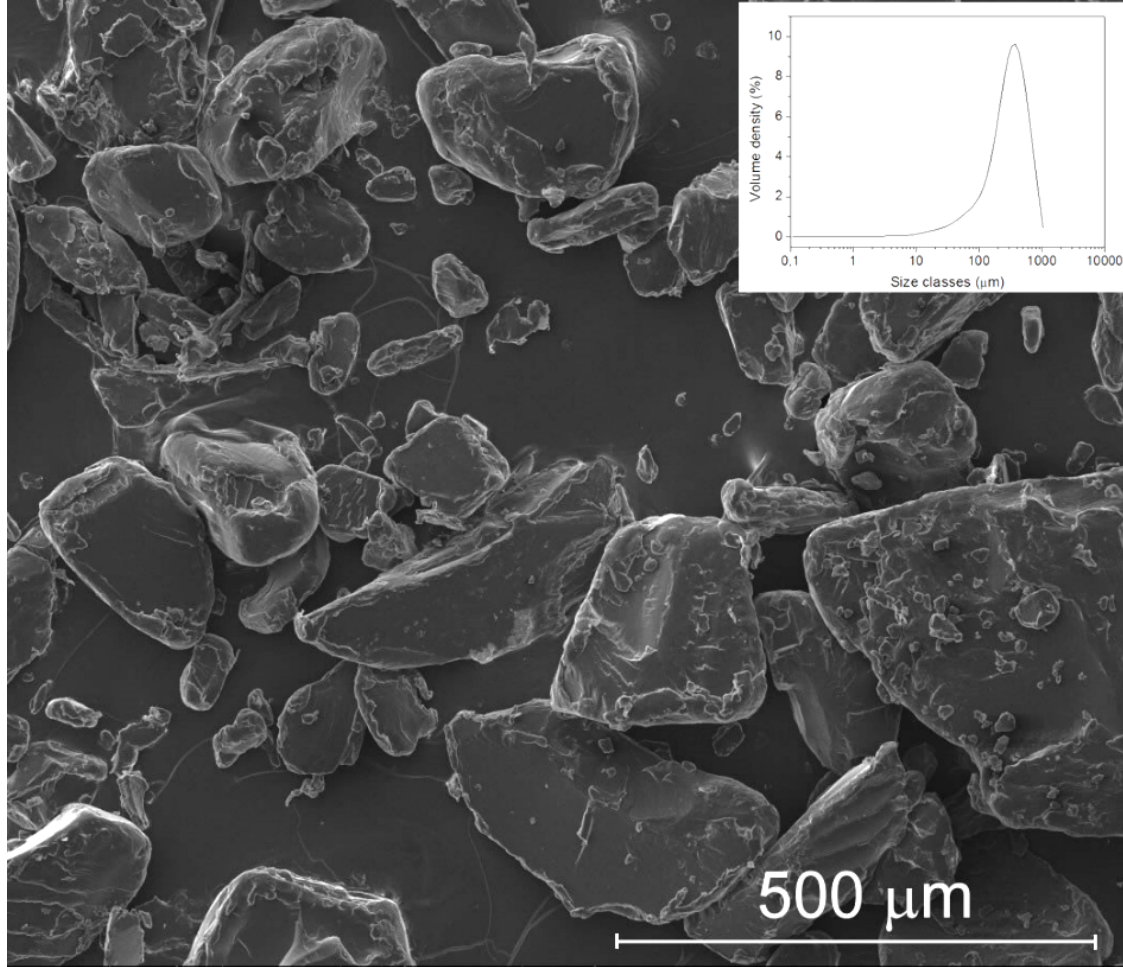
- Hexafluoroisopropanol + m-Cresol
- N-Methyl-2-pyrrolidon
- Phenol + Tetrachloroethane



Shredding/milling of PET bottles



Shredding/milling PET bottles

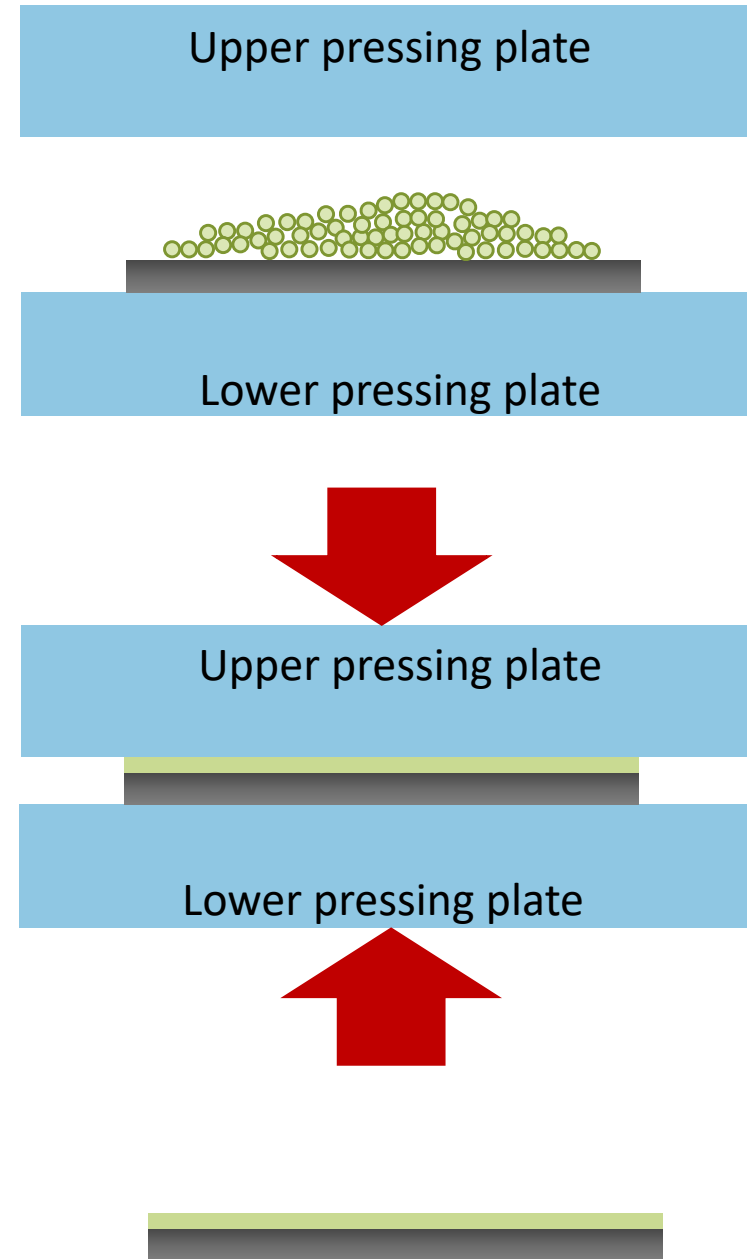


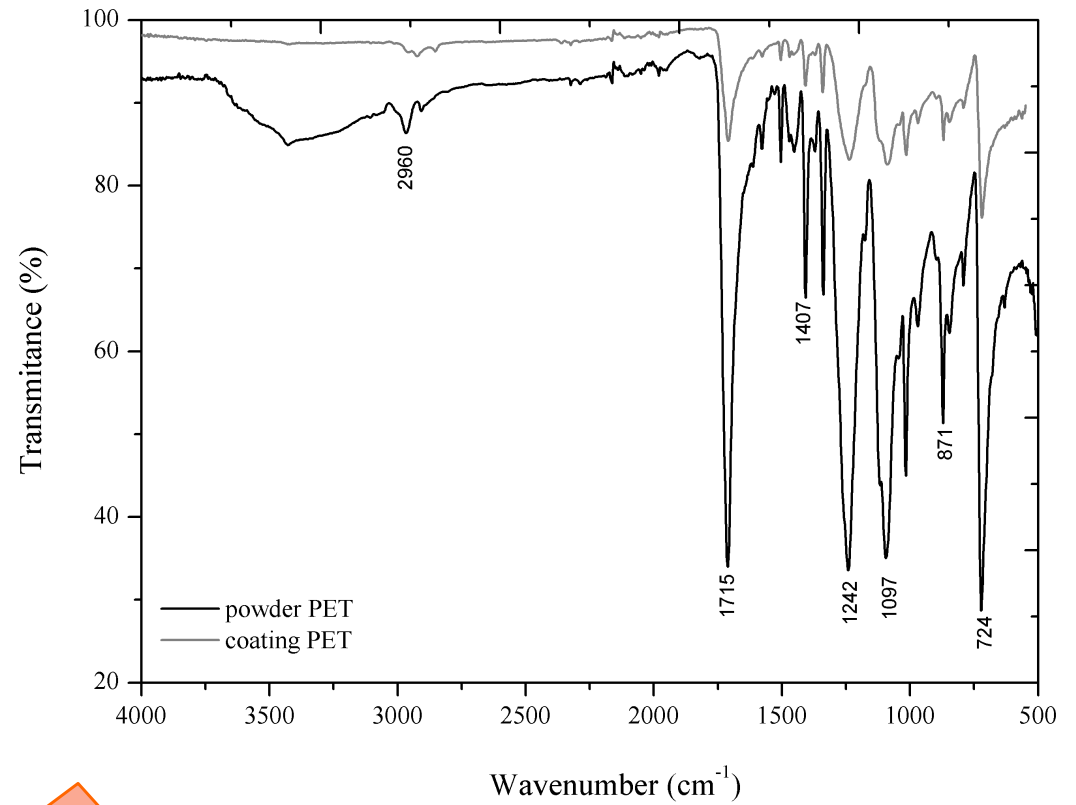
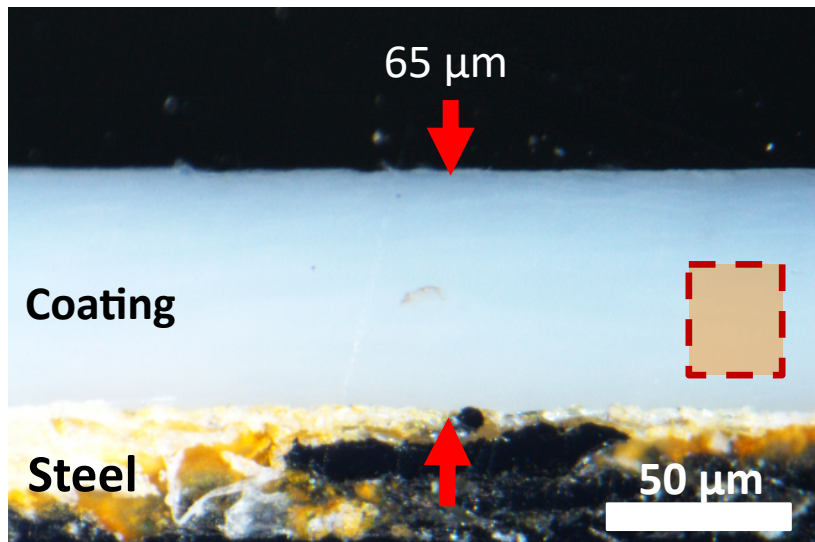
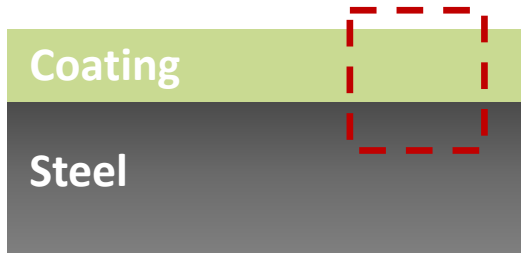
Parameter	Size (μm)
D(4,3)	340
Dv(10)	87
Dv(50)	310
Dv(90)	635

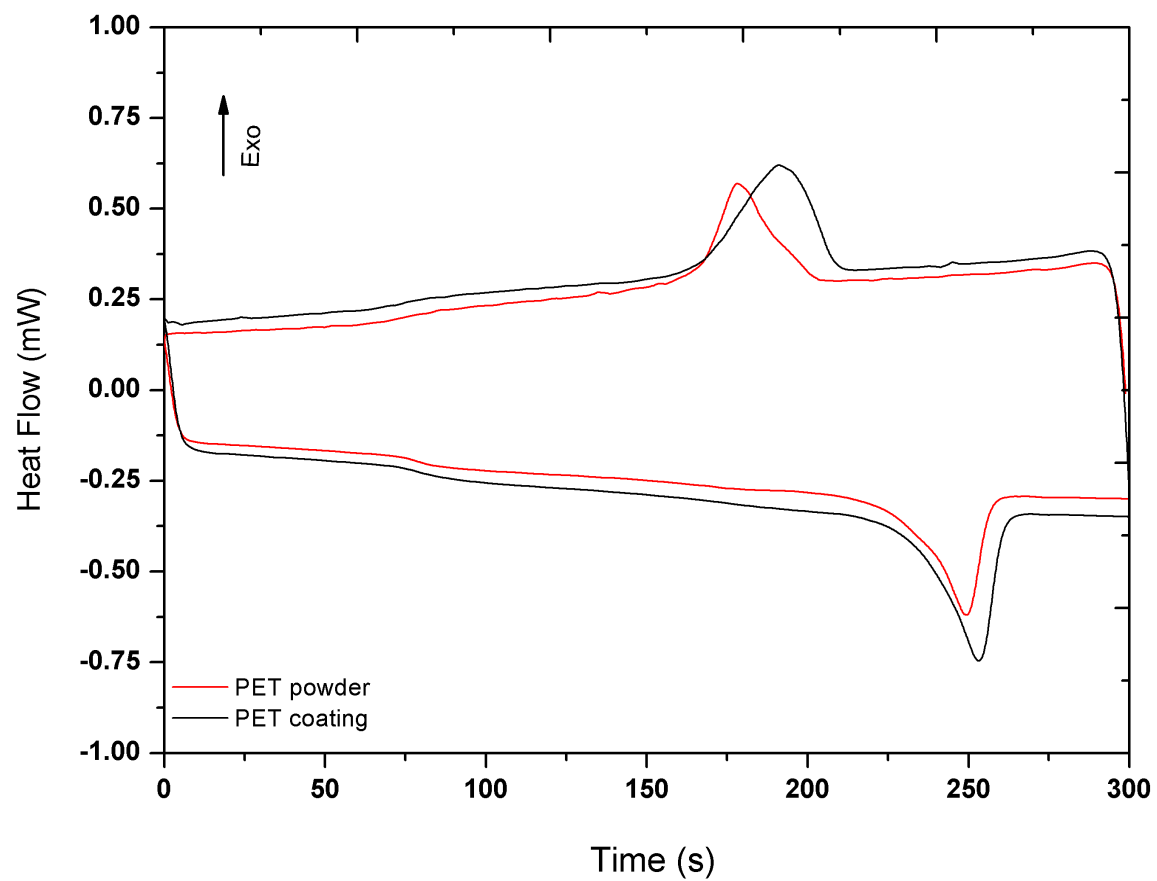
From powder to coatings



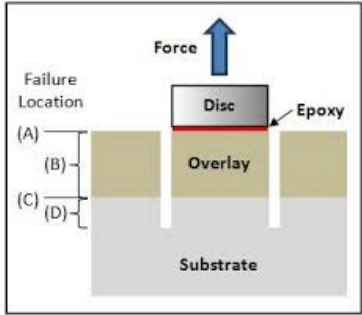
- ✓ 260 °C for 5 minutes without pressure
- ✓ 0.5 ton applied for 2 minutes
- ✓ 5 minutes cool down
- ✓ Conditioning at room temperature for 24 hours



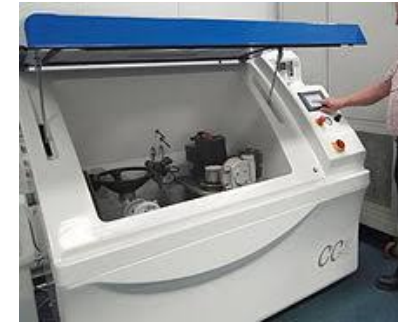




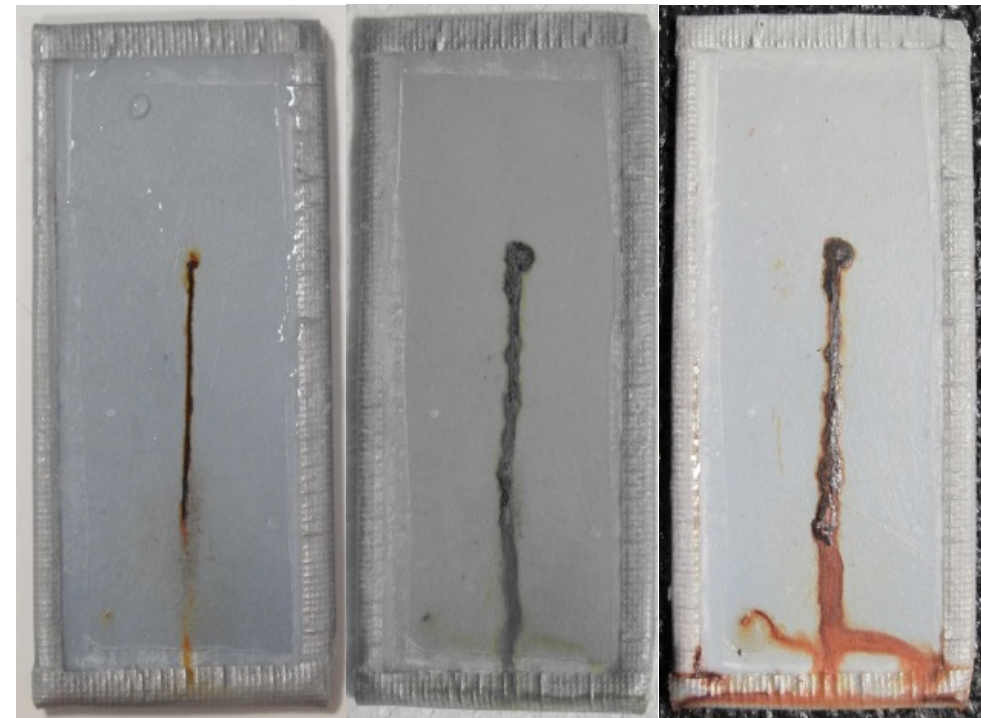
Sample	Glass transition Temperature (T_g)		Crystallization Temperature (T_c)		Melting temperature (T_m)		χ_c (%)	Decomposition temperature (T_d) (°C)
	Onset (°C)	Midpoint (°C)	T_c (°C)	ΔH_c (Jg ⁻¹)	T_m (°C)	ΔH_m (Jg ⁻¹)		
PET bottle	73.8	78.6	195.0	35.6	233.0	35.7	25.5	454.7
PET coating	72.8	80.0	209.0	46.8	235.0	44.4	31.7	455.0



Neutral Salt Spray Test



Samples	Thickness (μm)	Adhesion (MPa)	Reference
Polyester	≈ 290	4.8 – 6.2	[1]
Carboxylated polyester resin	50.0 ± 5	1.7 – 3.0	[2]
Saturated carboxylated polyester resin	90.0 ± 10	4 – 6.8	[3]
Post-consumer PET	65 ± 5	> 5	This work



72 h

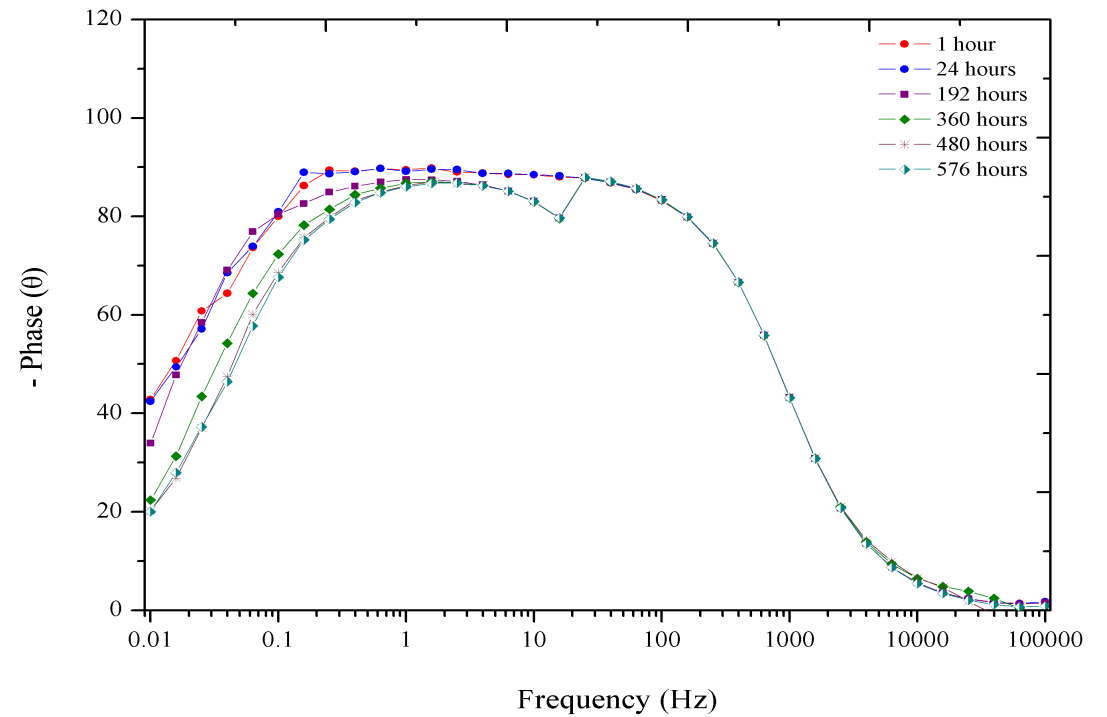
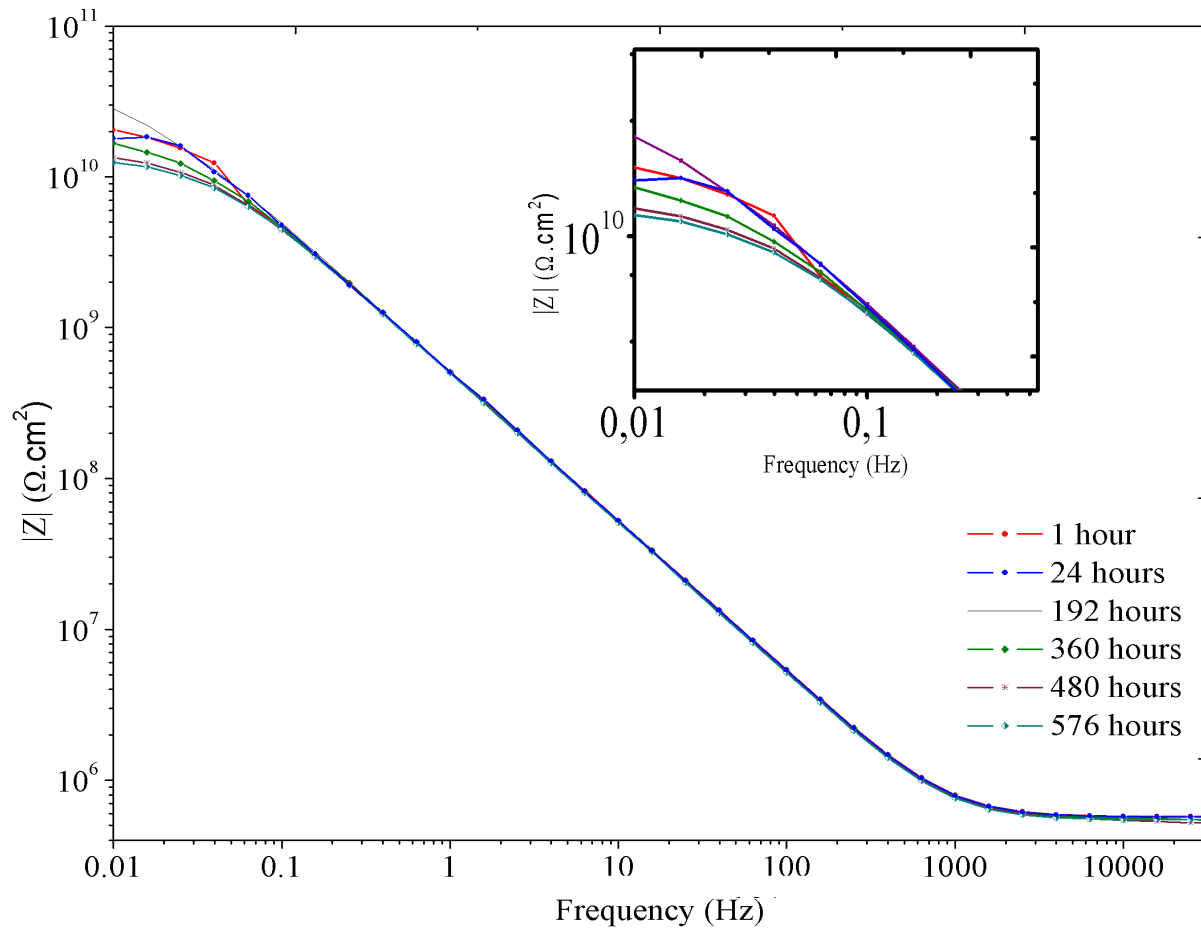
240 h

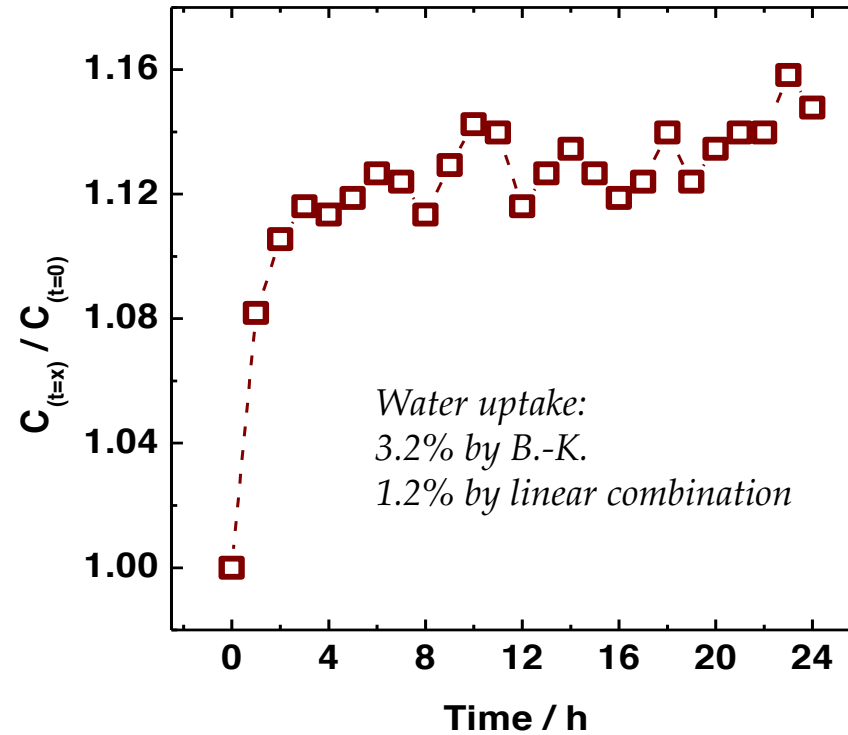
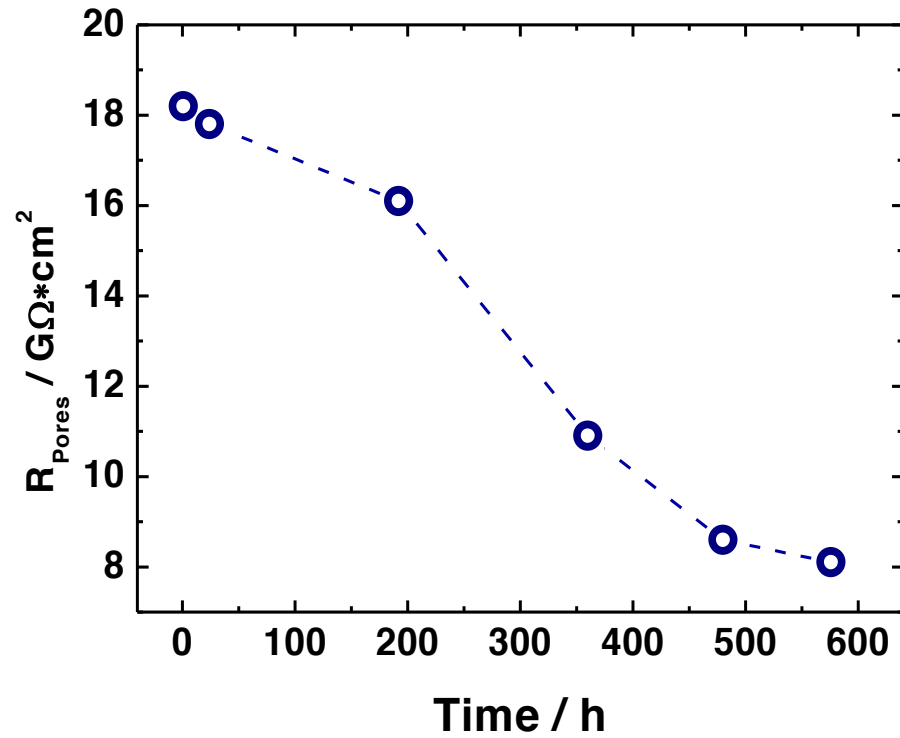
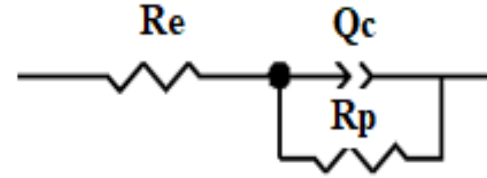
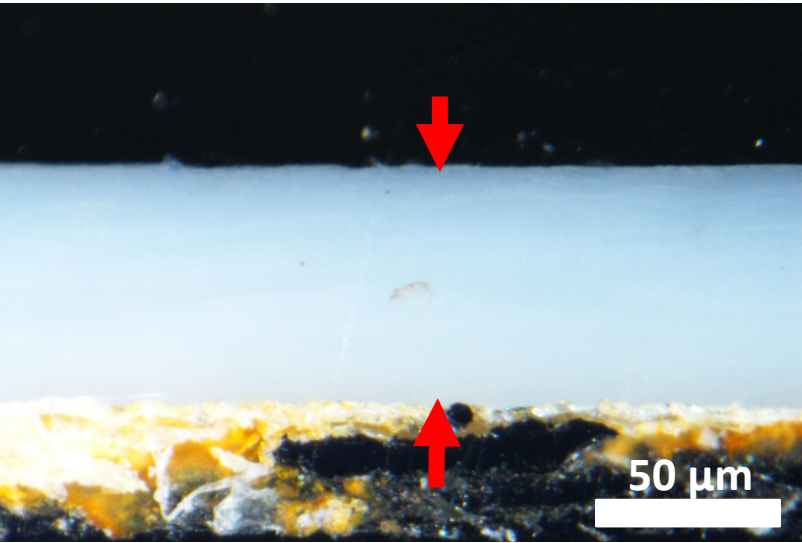
480 h

[1] Y. Takeshita et al. *Prog Org Coat.*, 2012, 75, 584–589

[2] S. Mirabedini et al., *Prog Org Coat.*, 2013, 76, 1625–1632

[3] M. Puiga et al., *Prog Org Coat.*, 2014, 77, 1309–1315





Comparison with literature data

Chemical nature	Thickness (μm)	Time (hours)	R_p ($\Omega \cdot \text{cm}^2$)	REF
Polyester powder coating	90 ± 10	0 - 500	$\approx 10^8 \rightarrow 10^5$	[1]
Polyester powder coating	30 ± 2	24 - 1368	$\approx 10^{10} \rightarrow 10^7$	[2]
Polyester powder coating	45 ± 3	168 - 1200	$\approx 10^7 \rightarrow 10^4$	[3]
Polyester/epoxy powder coating	45 ± 3	168 - 1200	$\approx 10^8 \rightarrow 10^5$	[3]
Polyester resin	30 - 40	0 - 720	$\approx 10^7 \rightarrow 10^4$	[4]
Post-consumer PET	65	0 - 576	$\approx 18 \cdot 10^9 \rightarrow 8 \cdot 10^9$	This work

[1] M. Puiga et al., *Prog. Org. Coat.* 2014, 77, 1309–1315

[2] B. V. Jegdić et al., *Corros. Sci.* 2011, 53, 2872–2880

[3] R. Mafi et al. *Corros. Sci.* 2008, 50, 3280–3286

[4] L. Ismail et al. *Pigment Resin Technol.* 2016, 45, 158–163

Phase 1

- Solvent dissolution
- Liquid application

PET based coatings from recycled bottles!

Phase 2

- Shredding
- Sintering

Corrosion protection guaranteed!

Phase 3

- Shredding
- Extrusion
- Milling
- Powder coating

Need of a more feasible application technique!





Stay Safe
AND
Healthy

