THE PROCESS SUSTAINABILITY FOR POLYESTER FABRIC HYDROLYSIS

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INTRODUCTION

High cristallinity of PET fibres ⟶ having few free active groups ⟶ modification of PET fabrics:

- improving sorption properties
- improving fabric comfort
- reducing static electricity
- improving aesthetics

Conventionally hydrolysis is carried out with NaOH (100 °C, 60’).

Reaction is **irreversible**.

INTRODUCTION

In the last ten years intensive research has been carried out on **enzyme lipase** for biodegradation and hydrolysis of PET.

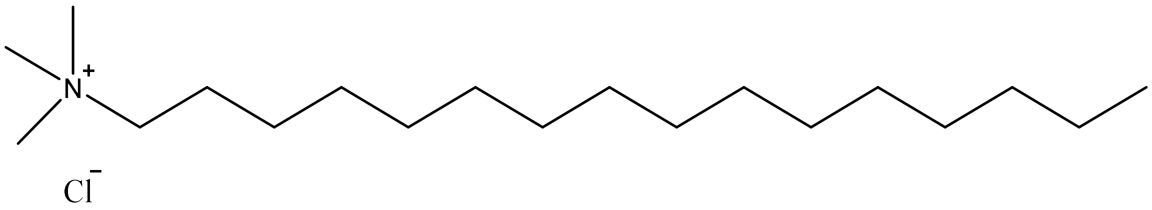
AIM

The present paper deals with the various hydrolysis of PET fabrics to investigate which is the most environmentally friendly modification of polyester fabric surface for achieving better hydrophilicity.

MATERIAL AND METHODS

Table 1: Labels and treatment of PET fabrics

Label	Treatment/process parameters
PET-H-T-t	Alkali hydrolyzed PET fabric (T=100 and 60 °C, t=60')
PET-H-T-t-HDTMAC	Alkali hydrolyzed PET fabric (T=100 and 60 °C, t=5' and 30', 4 g/L HDTMAC)
PET-E-T-t-conc.-pH	Lipase hydrolyzed PET fabric (T=100 and 60 °C, t=60', conc.=0.2 g/L, pH9)



Hexadecyl trimethyl amonium chloride

(HDTMAC)

MATERIAL AND METHODS

Fabric modification was made by batch wise method in stainless-steel bowls of instrument Linitest, Original-Hanau with LR 1:50.

The hydrolysis effects were evaluated by standard methods:

- fabric weight loss, **Δm [%]**, (ISO 3801:1977)
- breaking force, **F [N]**, and elongation, **ε [%]**, (dynamometer Tensolab MESDAN-LAB, ISO 13934-1:2013)
- whiteness degree, W_{CIE}, (remission spectrophotometer Spectraflash SF 300 Datacolor, ISO 105-J02:1997)
- yellowing indeks, **YI**, (DIN 6167:1980)

MATERIAL AND METHODS

The characterization of modified PET fabric surface was performed by scanning electron microscopy (SEM) with magnification 1000x.

Figure 1: Tescan, Czech Republic, FE-SEM, Mira II LMU

RESULTS

Table 2: Weight loss (Δm), loss in the breaking force (ΔF), elongation (ε) of hydrolysed PET fabrics

Sample	Δm [%]	ΔF [%]	ε [%]
PET	-	-	24.200
PET-H-100°C-60'	22.12	45.608	32.468
PET-H-60°C-60'	7.09	16.398	29.167
PET-H-100°C-5'-4 g/L HDTMAC	20.22	52.416	25.781
PET-H-60°C-30'-4 g/L HDTMAC	10.52	38.580	23.111
PET-E-100°C-60'-0,2 g/L-pH9	4.42	2.416	45.800
PET-E-60°C-60'-0,2 g/L-pH9	4.58	4.466	45.800

RESULTS

Figure 2: Breaking force (F) before (PET) and after hydrolysis of PET fabrics

RESULTS

Table 3: Degree of whiteness according to CIE (W_{CIE}) and Yellowing Index (YI) before and after hydrolysis of PET fabrics

Sample	W_{CIE}	YI
PET	68.7	4.16
PET-H-100°C-60'	72.4	2.88
PET-H-60°C-60'	74.7	2.51
PET-H-100°C-5'-4 g/L HDTMAC	74.9	2.34
PET-H-60°C-30'-4 g/L HDTMAC	74.4	2.49
PET-E-100°C-60'-0,2 g/L-pH9	68.3	4.14
PET-E-60°C-60'-0,2 g/L-pH9	67.9	4.40

RESULTS

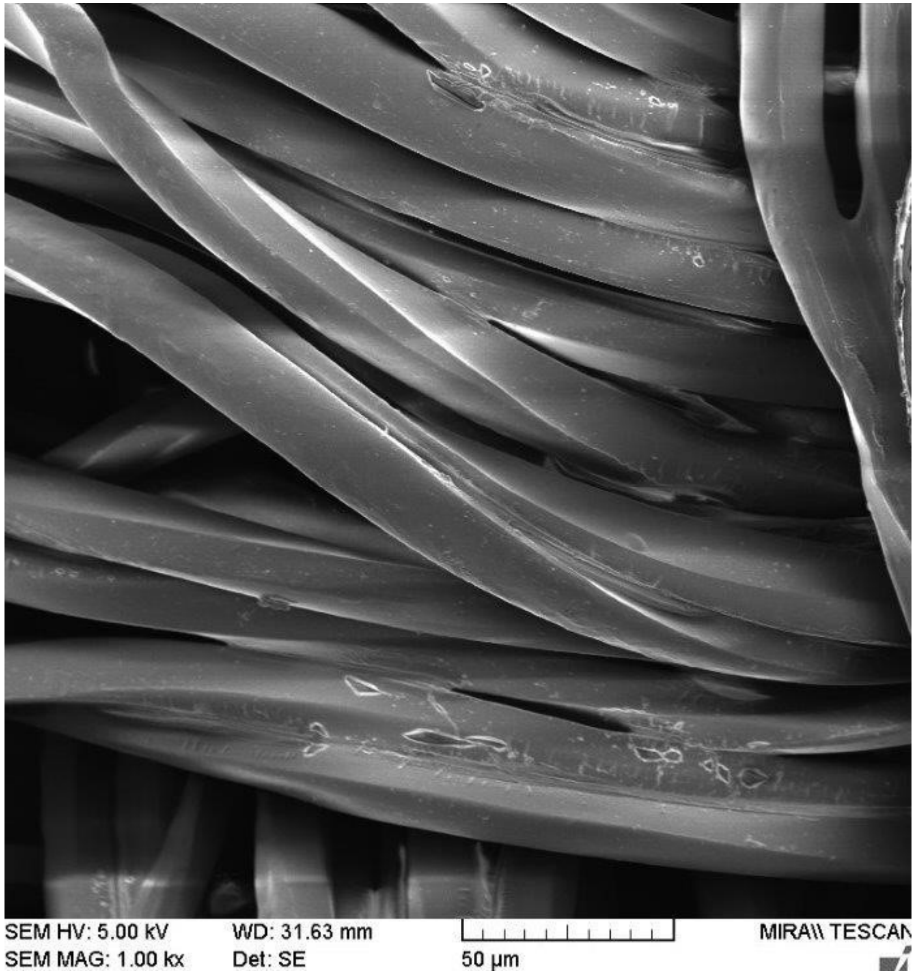
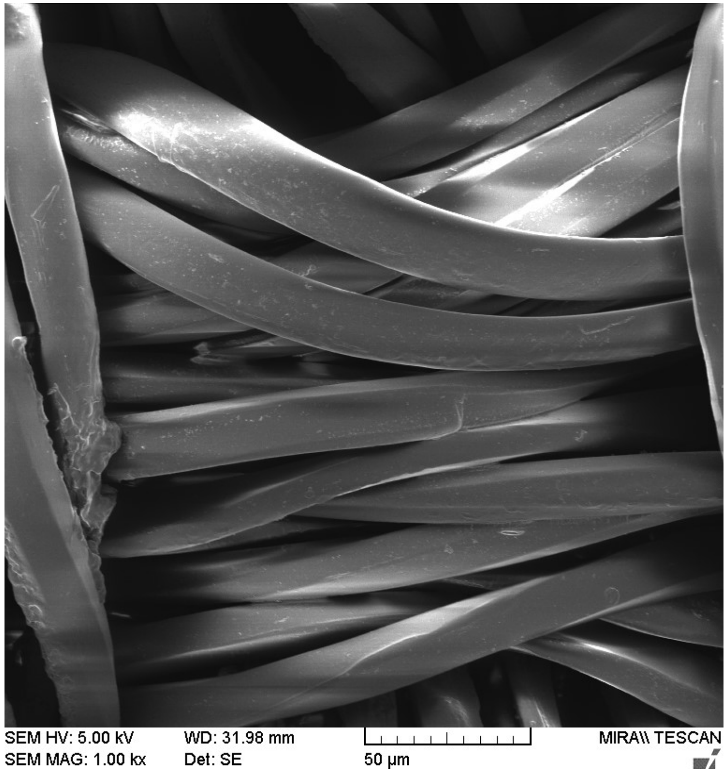


Figure 3: SEM micrograph of untreated PET fabric at magnification of 1000x

RESULTS

a.

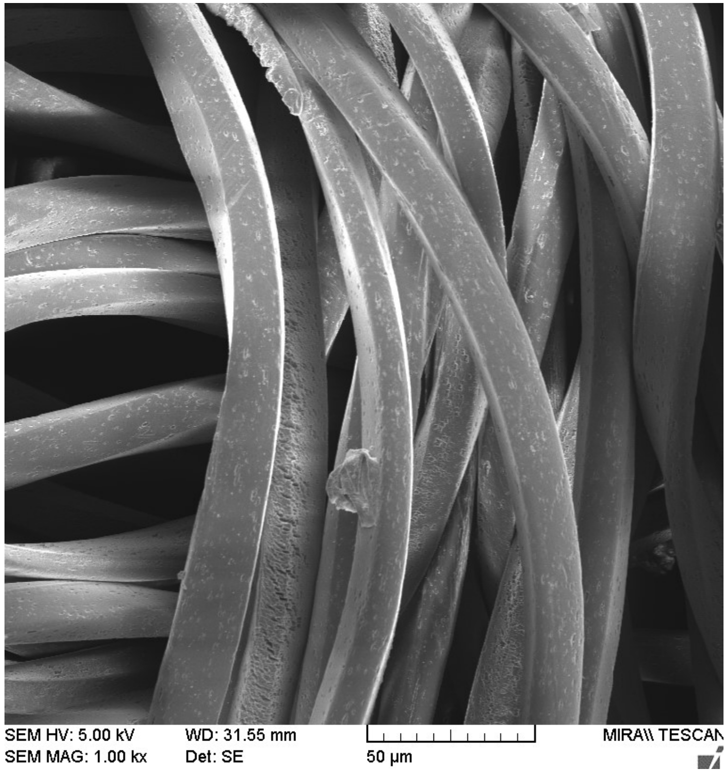


b.

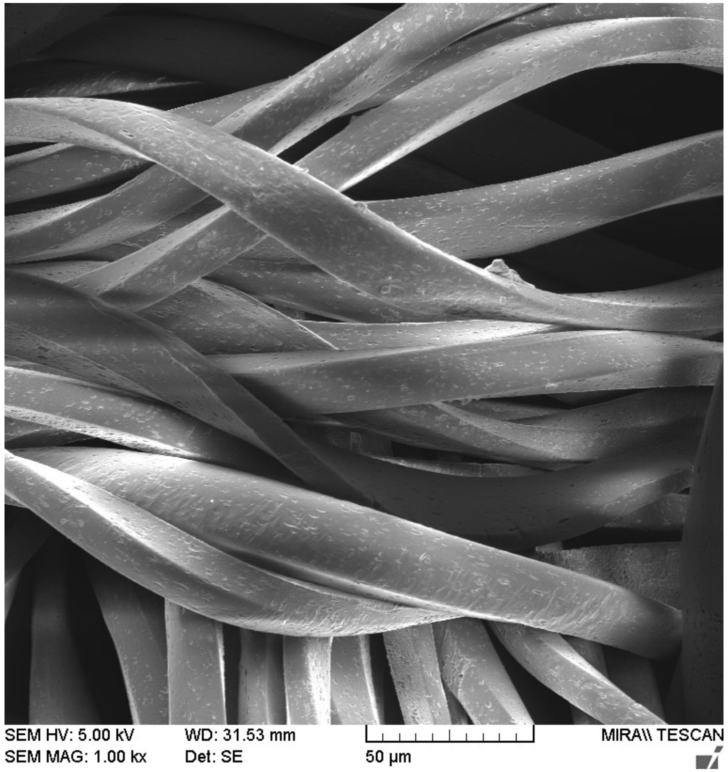
Figure 4: SEM micrographs of PET fabrics at magnification of 1000x:

a. PET-H-100°C-60', b. PET-H-60°C-60'

RESULTS



a.



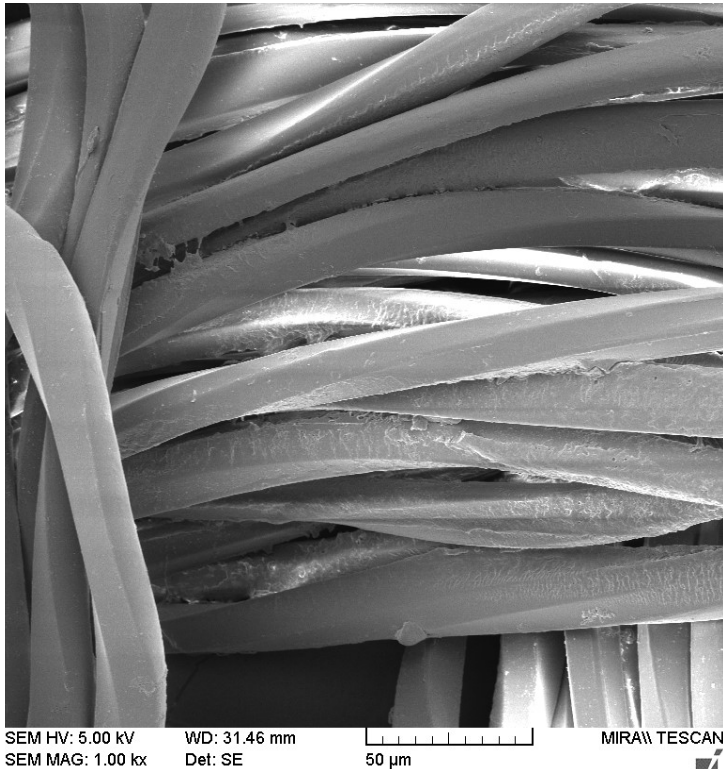
b.

Figure 5: SEM micrographs of PET fabrics at magnification of 1000x:

a. PET-H-100°C-5'-4 g/L HDTMAC, b. PET-H-60°C-30'-4 g/L HDTMAC

RESULTS

a.



b.

Figure 6: SEM micrographs of PET fabrics at magnification of 1000x:

a. PET-E-100°C-60'-0,2 g/L-pH9, b. PET-E-60°C-60'-0,2 g/L-pH9

CONCLUSION

It has been shown that it is possible to carry out the hydrolysis of PET in a more environmentally friendly way compared to conventional alkaline hydrolysis (100 °C, 60 min) by alkaline hydrolysis with the addition of HDTMAC (60 °C, 30 min).

This process is still not fully environmentally friendly with respect to the use of sodium hydroxide, but since good results were obtained at reduced temperature and time, it is economically and energetically more acceptable compared to the conventional process, and therefore more sustainable process.

CONCLUSION

Using lipase enzymes, the sustainability of the hydrolysis process will be achieved; the obtained results indicate more environmentally friendly process, at low temperature, but the time should be further researched.

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