Textile Innovations
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Institut für Textiltechnik und Lehrstuhl für Textilmaschinenbau | RWTH AACHEN UNIVERSITY

Melt-spun elastic yarns from TPE as enabler for (thermo-)mechanical recycling of elastic textiles

Introduction

Textiles are an essential part of daily life, serving purposes from comfort to protection and technical applications. With **global fibre and yarn production reaching an all-time high of 124 million tons in 2023 and clothing production more than doubling since 2000**, managing textile waste is of critical importance. Currently, over 73% of all used clothing worldwide is incinerated or landfilled, while **less than 1% are recycled in a closed loop**. A major barrier to textile recycling is the widespread use of fibre blends, with elastane-containing elastic textiles presenting a particular challenge. [1, 2] The use of so-called elastanes, dry-spun filament yarns from elastomeric polyurethanes, is the primary method for adding elasticity to textiles. Despite its **typically low content (2–20 wt.-%) in blended textiles, elastane significantly hinders recycling processes**. Due to the cross-linked structure, melting and regranulation in a (thermo-)mechanical recycling process for synthetic textiles is not possible. [3] With the increasing use of elastane in textiles and its production growing at approximately 6.4% annually, alternative solutions are urgently needed. [4] **Melt-spinnable thermoplastic elastomers (TPEs) offer a promising pathway for thermoplastic elastic yarns that enable textile recyclability**. By selecting polymer combinations with matching processing requirements and material compatibility, the fibre blends in textiles can be optimized for recyclability. This research explores the recycling potential of textiles made from polyethylene terephthalate (PET), the most widely used fibre material, combined with a selected TPE.

Only < 1% of used textiles are recycled in a closed loop [2].

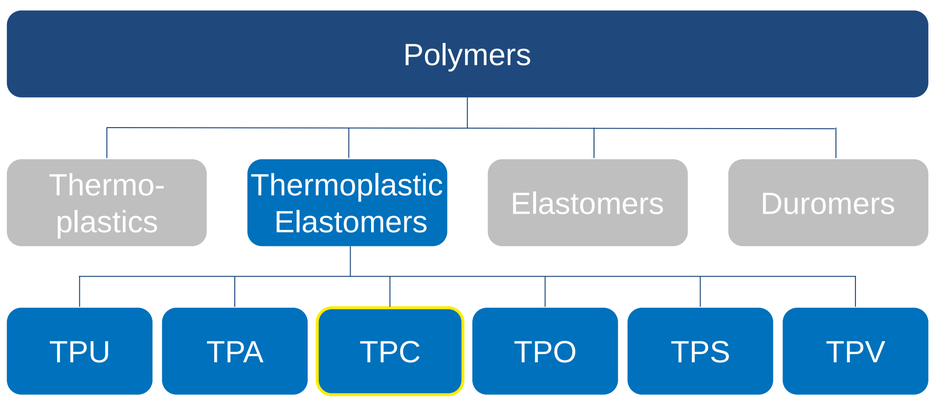
Deficit and solution approach

Elastanes currently produced from **elastomeric polyurethanes**

Thermal degradation or filter clogging during recycling due to non-meltable polymer character

Solution: Change of material base for elastic yarns to **thermoplastic elastomers**

Selection of **thermoplastic copolyester elastomers (TPC)** for better compatibility with PET



Methodology

1 Primary materials on granulate level

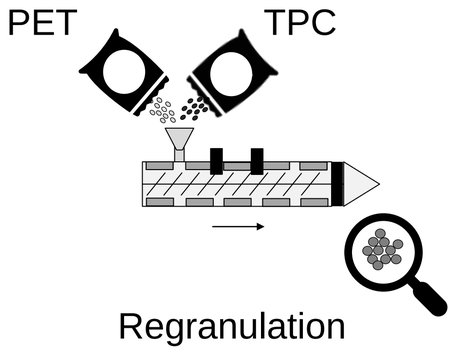
- **PET**: Typical PET grade for textile fibre production
- **TPC**: Thermoplastic elastomer for elastic yarn production

PET granulate

TPC granulate

2 Blending and regranulating of PET and TPC

- Blending with a double-screw extruder, TPC content based on typical elastane shares in textiles up to 10 %
- Blend analysis including REM

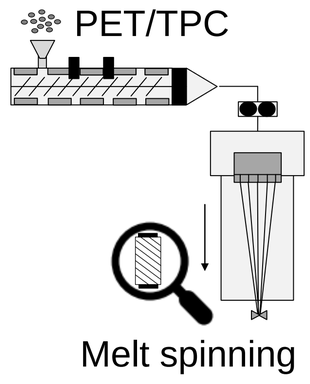


Regranulation

PET/TPC regranulate

3 Melt spinning of PET/TPC regranulates

- Spinning of the PET/TPC blends with a melt spinning plant in pilot scale
- Filament analysis including optical microscopy



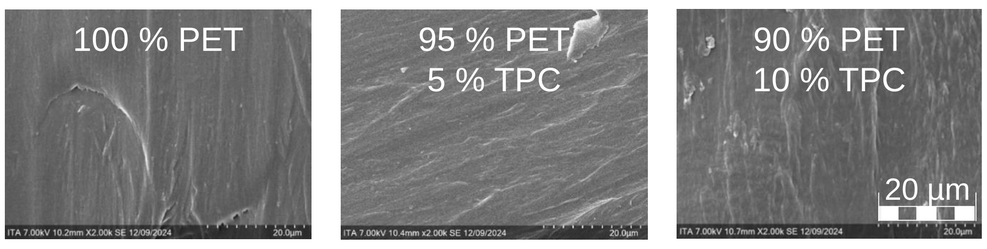
Melt spinning

PET/TPC filament yarn

Results

Blending trials and blend analysis:

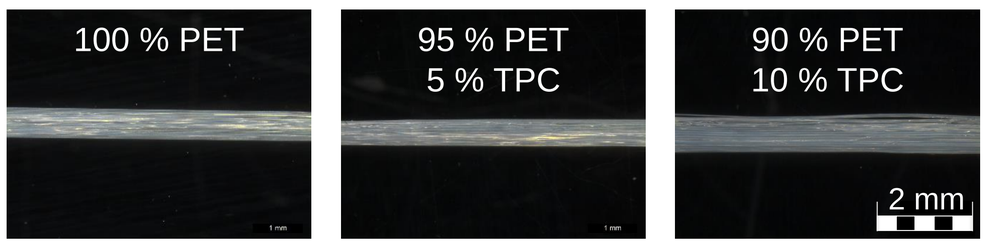
- Stable strand extrusion and regranulation for all TPC contents
- Good miscibility with PET and optically homogenous blend granulates at all tested ratios up to 10 % TPC
- No agglomeration or discoloration observed



REM images of PET and PET/TPC blend granulates

Melt spinning trials and filament analysis:

- Stable filament formation and multifilament spinning processes with winding speeds up to 1800 m/min for lower TPC contents
- Blend with 10 % TPC still melt-spinnable but process parameters need to be adjusted and partly uneven yarn appearance



Optical microscopy images of PET and PET/TPC multifilament yarns

Conclusions

- PET/TPC blends with moderate TPC contents are suitable for melt-spinning
- Joint processability of PET and TPC confirmed → TPC is a promising elastane alternative for recyclable textiles
- Future work: Optimise blend ratios and spinning parameters especially for higher TPC contents

References

[1] Textile Exchange; Materials Market Report September 2024 (Revised January 2025)

[2] Ellen MacArthur Foundation; A new textiles economy: Redesigning fashion's future; 2017

[3] Wissel, R.; Ludes, A.; Küppers, B.; Sorting and Recycling of Elastic Textiles. In: Thiel, J.; Gries, T. (Hrsg.): Elastic Yarns and Textiles; München: Hanser; 2024

[4] Sinitsa, A.; The Market of Elastic Yarns. In: Thiel, J.; Gries, T. (Hrsg.): Elastic Yarns and Textiles; München: Hanser; 2024

ITA Group International Centre for Sustainable Textiles

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