

# ISOPREP

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## TECHNICAL BROCHURE



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# TABLE OF CONTENTS

- 01 WE ARE NEW PLAYER IN THE FIGHT AGAINST PLASTIC POLLUTION
- 02 MISSION & VISION
- 03 ISOPREP INNOVATIONS
- 04 ISOPREP INNOVATIVE TECHNOLOGY
- 05 ISOPREP PROCESS 1 - MECHANICAL SORTING PLANT
- 06 ISOPREP PROCESS 2 - POLYPROPYLENE PURIFICATION PLANT
- 07 ISOPREP FIBRES
- 08 MEET ISOPREP PARTNERS
- 09 CONTACT

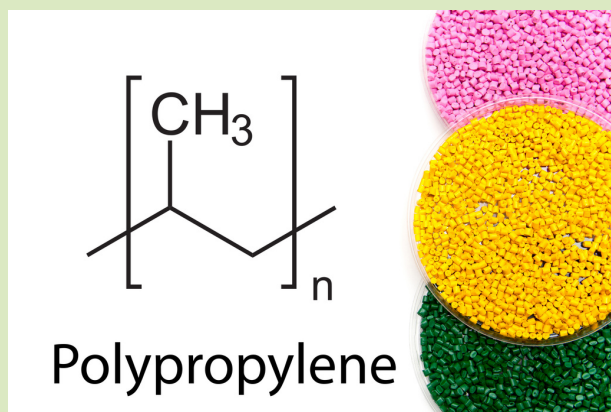
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# WE ARE A NEW PLAYER IN THE FIGHT AGAINST PLASTIC POLLUTION

**ISOPREP** - A European funded research project which aims to revolutionise the recycling of difficult-to-recycle polypropylene (PP) products, contributing to the development of the circular economy not reliant on fossil fuels with environmental benefits of lower CO<sub>2</sub> emissions.

Polypropylene, chemical formula (C<sub>3</sub>H<sub>6</sub>)<sub>n</sub>, is the world's second most widely used commodity polymer (after polyethylene, PE) accounting for **13%** of total usage by value (23% by volume). It is employed for a variety of purposes including packaging, textiles, furnishings, pipes, vehicle components, electrical equipment, rope and even banknotes.



Whilst PP is widely utilised and often used as a single-use plastic, it is one of the least recycled post-consumer plastics in the world, with the majority ending up in landfills. As PP products take around **20-30 years** to fully decompose, they pose a severe threat to the environment. The problem we face is that the properties that make PP so fit for purpose also make it extremely difficult to recycle. For example, the high melting point of PP means that to burn end-of-life PP products requires an extremely high energy input and generates CO<sub>2</sub> in a similar manner to burning oil. Burning large-scale amounts of PP is just not energy-efficient or environmentally friendly. Also, as an oil-derived polymer, PP is a non-sustainable resource, and burning it only necessitates further consumption of fossil fuels to replace it.

ISOPREP developed a method for recycling end-of-life PP products back into virgin quality PP by utilising a novel solvent (**ionic liquid**). We have developed and engineered this process at pilot scale using **1 tonne** of waste PP **carpet** as the feedstock.

The ISOPREP project runs from October 2018, has a budget of **€ 6.3M**, and is funded by the **Horizon 2020** programme (grant agreement 820787) to provide efficient recycling processes for plastics containing materials. The project is led by independent research and technology experts, TWI (UK), and partners include: London South Bank University (UK), Floteks (Turkey), Fraunhofer (Germany), Sabanci University (Turkey), Institute of Processing and Engineering (Austria), RotaJet Systems Ltd. (UK), Axion Recycling Ltd. (UK), and the Centre for Nanotechnology and Smart Materials (Portugal).



# MISSION & VISION



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**THE ISOPREP PROJECT OFFERS AN INNOVATIVE APPROACH TO RECYCLING END-OF-LIFE POLYPROPYLENE PRODUCTS BACK INTO VIRGIN QUALITY POLYPROPYLENE USING SOLVENT BASED TECHNOLOGY.**

ISOPREP Mission is:

- To produce virgin quality polypropylene from polymer waste feedstock consisting mainly of PP.
- To achieve virgin quality PP, cost competitive with commercial polypropylene manufactured from fossil fuel resources.
- To produce virgin quality polypropylene with similar specifications needed by the customer.

Key **benefits** of ISOPREP technology:

- Extraction of virgin quality polypropylene suitable for value added end use from waste.
- Reduced need for production of polypropylene from fossil fuels and less disposal volume.
- Comparable cost with producing PP from fossil sources.
- True recycling for polypropylene waste enabling a circular economic approach.
- Entirely closed loop system with negligible loss of solvent.
- Negligible emissions and non-polluting.
- Non-toxic solvent.
- Removal of dyes, colours and impurities.
- Avoiding end of life PP products to landfill and sea.

# ISOPREP INNOVATIONS



## COMMERCIAL

- ISOPREP's PP dissolution recycling system extracts virgin quality PP from mixed polymer feedstock. Although the proposed aim of the EU Project is to recycle PP carpet scrap to end up with value added PP, the system can dissolve any mixed PP waste to achieve value added PP, as long as the main material in the mixture is PP.
- The plant aims to competitively enter the virgin PP market with a “recycled PP” sign, to fulfill the urgent need of the industry to use recycled materials, aspired by authorities throughout the world.
- ISOPREP technology will enable the development of a circular economy and remove the need for landfill disposal.
- Achievement of a closed loop system of the pilot plant aims to lose between 1 - 5% of solvent per batch, which is viable for the end cost of the virgin like PP achieved with the ISOPREP system. The life cycle analysis and economic analysis of our proposed system design suggests that it will be able to gain virgin like PP from scrap at commercially viable prices.

## ENVIRONMENTAL

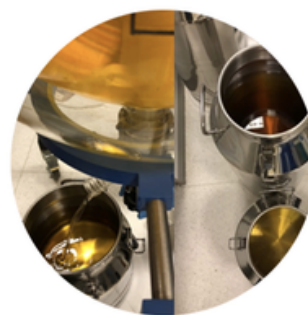
- The environmental impact of the ISOPREP process was evaluated with a Life Cycle Assessment.
- Some further optimisation potentials from the pilot plant stage to an industrial scale were identified.
- For an industrial scale, the environmental impacts of the ISOPREP process can be in the same range as the benchmark, representing the primary PP production and in addition to that the conventional carpet waste treatment.
- The ISOPREP process represents a contribution to a circular economy. It is therefore independent from fossil sources as a feedstock.
- The PP recycling process can be applied to other complex waste streams. These could lead to lower environmental impacts depending on the pre-treatment needed.

# ISOPREP INNOVATIVE TECHNOLOGY

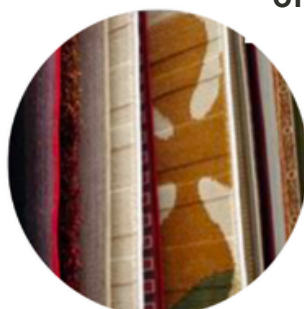
The ISOPREP uses a novel ionic solvent designed for highly tuned solubility of polypropylene



- 1 The well-designed ISOPREP ionic liquid has solubility greater than 50 mg/ml at temperatures greater than 128 °C.
- 2 All dyes and impurities in the recycled PP carpet feedstock have a solubility of zero in the ISOPREP ionic liquid.
- 3 The solvent also dissolves polyethylene (PE). Discrimination between PE and PP can be readily achieved via control of the process temperature.
- 4 The ISOPREP ionic liquid is non-toxic and has ultra low vapour pressure, thus generating negligible emissions and pollution



The ISOPREP ionic liquid highly tuned to dissolve only PP



Waste PP carpet at end of its useful life



# MECHANICAL SORTING PLANT

The purpose of the pilot plant is to obtain sufficient data to assess the feasibility of a real size plant. The real size plant would be constructed where large amounts of scrap PP can be collected, aiming to recover and purify PP from the waste with economical prices.



The ISOPREP's Mechanical Sorting Plant offers:

- **Waste Carpet Size Reduction**



**Shredding**  
using a 40 mm screen



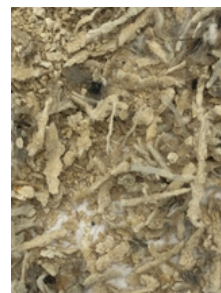
**Granulating**  
using a 8 mm screen



**Pulverising**  
into fine powders

- Floating fraction contains approx. **75% PP**
- Sinking fraction contains approx. **1% PP** (very little PP is lost in the Density Separation process)

- **Waste Carpet Density Separation**



**Floating fraction**

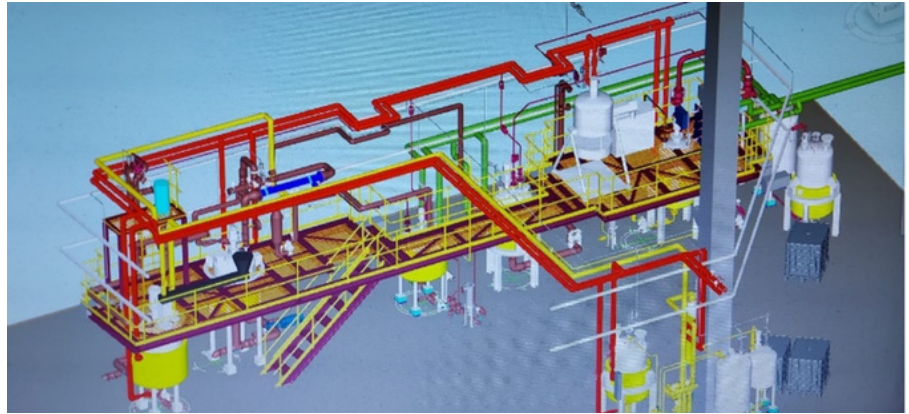


**Sink fraction**

# POLYPROPYLENE PURIFICATION PLANT



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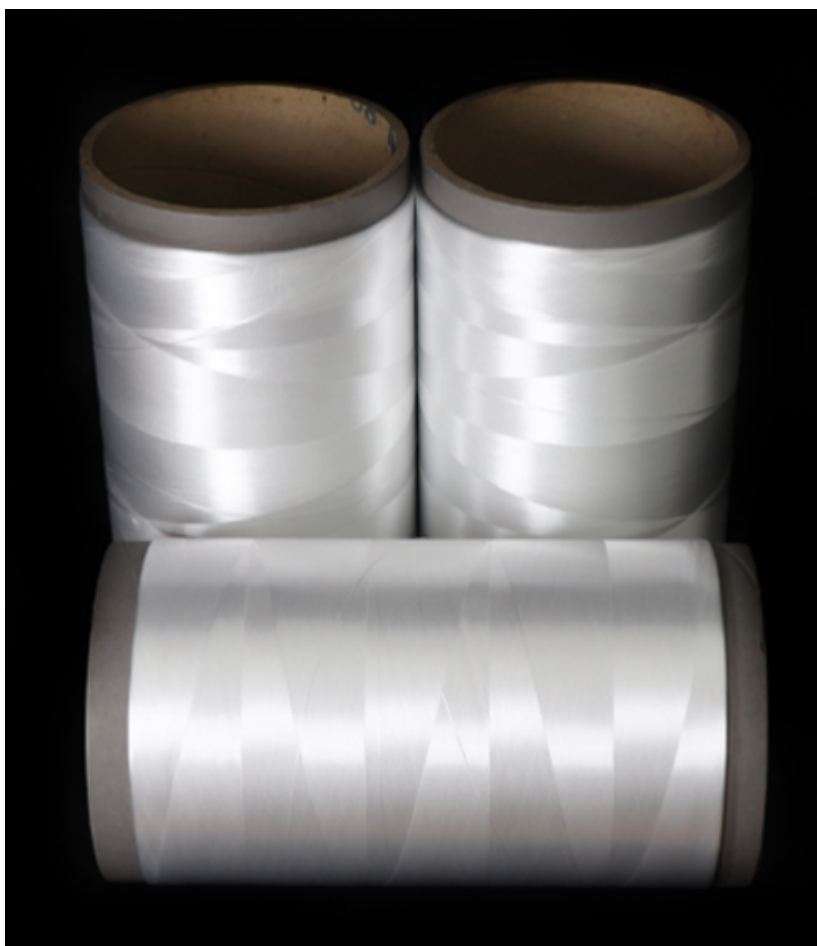
The ISOPREP's Polypropylene Purification Plant offers:

- **Synthesis and Storage** of the Ionic Liquid
- **Dissolution** of carpet or other waste in Ionic Liquid in order to dissolve PP
- **Coarse Filtration** to remove large particles of undissolved materials and any suspended particulates
- **Leaching** to remove pigments and dyes with a membrane module
- **Precipitation** to separate PP from ISOPREP ionic solvent with an anti-solvent and special vessel design
- **Fine Filtering** to remove the precipitated PP from the liquid phase
- **Distillation** to separate ionic solvent from anti-solvent, so that both liquids can be recycled for reuse
- **Compounding and Granulating** the PP achieved from ISOPREP process, ready to be used by various plastic industry





# ISOPREP FIBRES



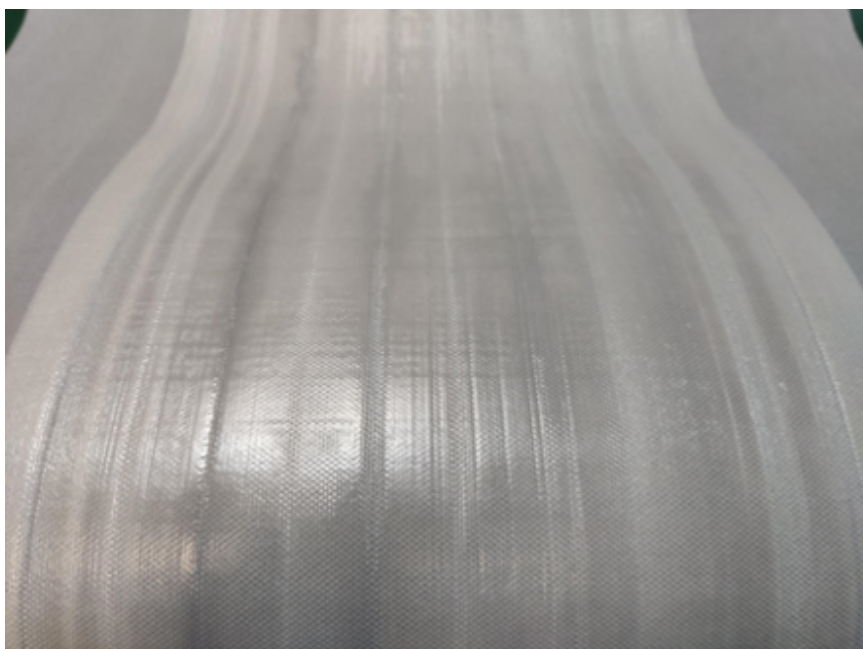
The ISOPREP's fibres produced from 100% recycled ISOPREP PP have equal quality as the fibres produced from commercial virgin PP from fossil fuels.

The properties of the ISOPREP Fibre:

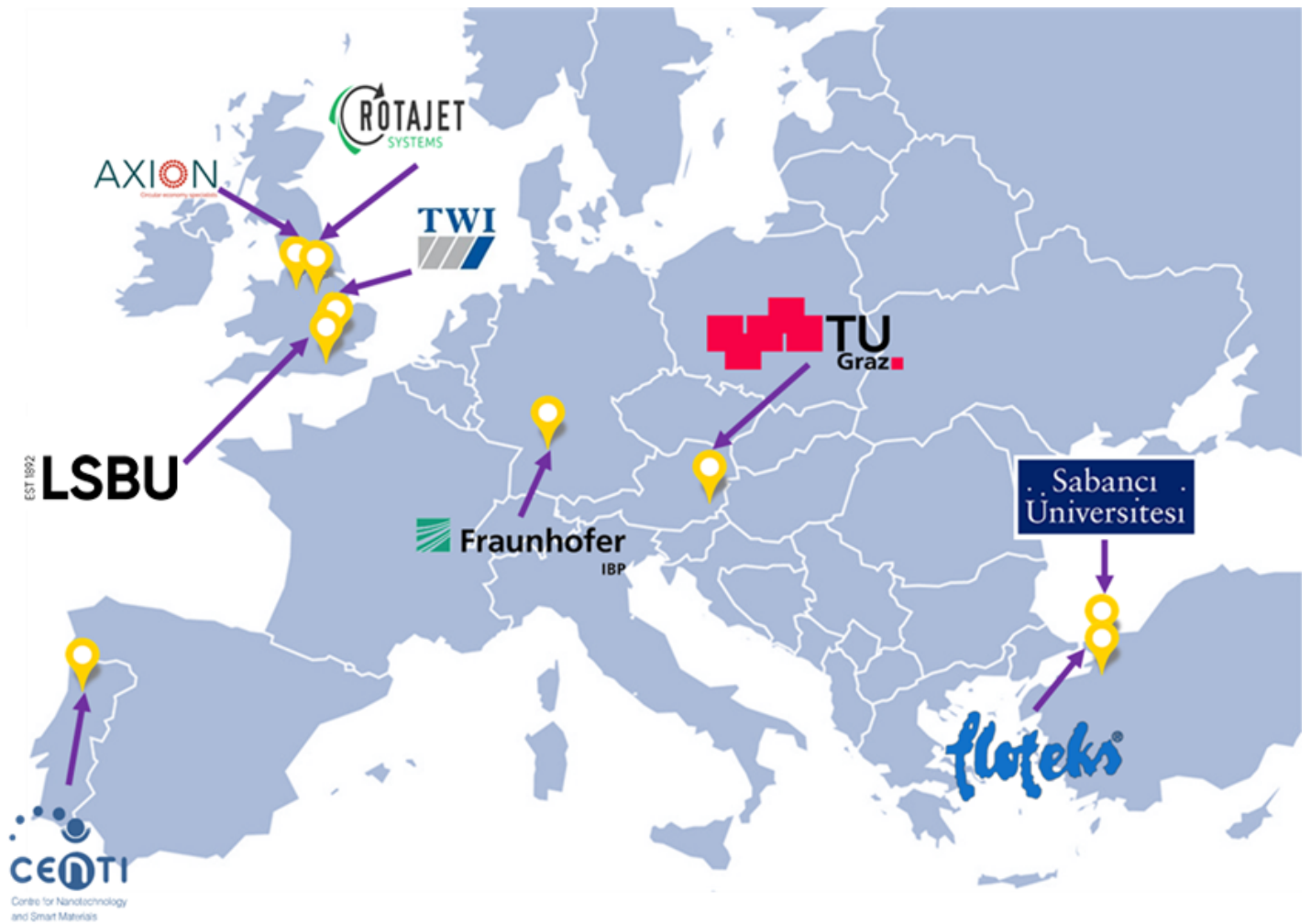
- **Linear Density:** between 100 – 2000 dtex
- **Tenacity:** from up to 5 to 8 gf/den
- **Antimicrobial:** 99.97% E. coli; 99.99% MRSA
- **Antistatic:** lower than  $1E10 \Omega/sq$ . Dissipative
- **Flame Retardant:** no flame spread

Commercial PP

ISOPREP PP



# MEET ISOPREP PARTNERS





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