# A New Circular Economy Concept: Textile Waste For Chemical And Textile Industries Feedstock

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**Abstract** The RESYNTEX project aims at designing, developing and demonstrating a new industrial symbiosis between textile waste and the chemical industry. The new original symbiosis is based on the chemical/enzymatic transformation of textile waste in a form that facilitates the easy take up as feedstock by the chemical industry in order to produce high added value chemicals. The parallel production of various high added value products ensures competitive production costs for the chemical market. As a result, economic advantages can be provided besides prevention of industrial environmental problems. The project will consider and demonstrate the whole value chain starting from the citizen behaviour change and the textile collection of unwearable textiles, improving and automatizing the industrial sorting, demonstrating the production of the transformed textile components and the symbiosis with the obtained chemical products and finally analysing the best economic models and policy actions for a successful introduction in EU markets.

**Keywords:** textile waste, recycling, chemical depolymerisation, enzymatic transformation, circular economy.

## 1. Introduction

According to the statistic [1] we can estimate that textile waste annual volumes will reach 17 Mt in 2020. Targeting a significant increase in collection rate (50 % in 2020) and considering that 23 % of textile waste is constituted of re-wearable clothes and remaining waste could be recycled at a rate of 95 %, we can estimate a potential of 6.2 Mt of fibers per year that could be converted into new feedstock. In the long term (post 2020), reaching 100 % collection would give access to more than 12.4 Mt of fibers. As a consequence, there is a strong need to develop a new industrial symbiosis based on this textile waste stream associated with adapted processes in order to achieve an efficient recycling especially for non-wearable textile waste and move away from landfilling and energy recovery.

### 1.1 RESYNTEX Consortium

RESYNTEX has 20 project partners from across 10 different EU member states. Partners include industrial associations, businesses, SMEs and research institutes. Working together, the group creates an effective model for the whole value chain.

RESYNTEX Consortium


## 2. Experiments

The main objective of WP4, where University of Maribor is currently mostly involved, is optimisation of a physicochemical recovery/transformation process via depolymerisation of textile waste.

Scope and goal: Total chemical depolymerisation of PET or PA material after sequential protein and cellulose removal.

This eco-friendly process comprises of:

- polyamide recovery with the production of PAs oligomers and
- polyester recovery and the production of PET monomers

Figure 1: Laboratory scale high pressure, high temperature reactor.

Relevant issues:

- influence of impurities on PAs and PET depolymerisation, yield, efficiency and purity; impact of other organic and inorganic waste on chemical transformation.
- optimization of production of added value feedstock for chemical industry in a pilot plant.

Figure 2: Pilot high pressure and high temperature plant.

## 3. RESULTS AND DISCUSION

### 3.1 Polyamide recovery with the production of PAs oligomers

Chemical depolymerisation of PA6 was performed – promising results were obtained (liquid fractions which precipitate after few hours were obtained) by high temperature and high pressure hydrolysis with high excess of water. By $^{1}$H NMR it was proved that mainly PA6 dimers were produced. With less harsh conditions, several water non-soluble oligomers were produced.

### 3.2 Polyester recovery and production of PET monomers

Testing of PET depolymerisation efficiency according to experimental conditions P, T and t and PET type (high and low viscosity type), with and without the present of catalyst was carried out. The degree of chemical depolymerisation of virgin PET polymers was preliminary determined gravimetrically, by carboxylic group number, FTIR spectroscopy and DSC.

After depolymerisation of PET textile materials 95 % of monomer (terephthalic acid) was obtained (proved by $^{1}$H NMR).

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**References**

1. JCR Scientific and Technical Report, 2010

2. Grand Agreemnet Number 641942-Resynex