什么是回收聚酯？

聚酯是一种由石油制成的合成纤维。它由聚对苯二甲酸乙二醇酯（PET）聚合物组成。它天生耐用、弹性好且快干。聚酯是世界上最受欢迎的纤维。它用于服装以及家居、汽车、建筑、过滤和个护。

回收聚酯是由废塑料原料制成的聚酯。这可能是塑料水瓶、工业聚酯废料或聚酯或聚酯混合物的衣物。

从化学、性能和耐用性来看，回收聚酯和原始聚酯一样好，包括强度高和功能性强。然而，它对环境的影响比传统聚酯小，因为生产过程中不需要提取石油所需的能量。

回收聚酯是如何制作的？

有两种不同的方法可以用来制作回收聚酯。它可以通过化学回收方法制作，也可以通过机械方法制作，这是更常用的途径。

**机械回收**利用的是从PET树脂中制作的透明塑料（聚对苯二甲酸乙二醇酯）瓶子。这些瓶子被清洗、粉碎、熔化和挤出成新的PET纤维。机械方法使用的是后期消费的资源和更少的能量。PET瓶的回收比许多其他塑料废料更实用，因为它是一个相对纯净的材料，不需要染料和其他功能性添加剂。它必须通过FDA的食品包装要求，这限制了添加有害化学物质的能力。用于装水和其他软饮料的塑料瓶子几乎完全是由PET制成的，这简化了回收设施的分类过程。

**化学回收**涉及使用化学物质将聚酯纤维分解回其原始单体，然后聚合回新材料。聚对苯二甲酸乙二醇酯（PET）聚合物通过化学反应返回其原始乙二醇和对苯二甲酸单体。聚合后形成的纺织品与原始聚酯难以区分。这种方法相当昂贵，并且主要用于染色和染色后的聚酯产品。

化学回收的优点包括：

+ 过程中得到的新化学品或单体可以被用来制作各种新材料，而不只是聚酯。
+ 废物流不需要像设计为机械回收的废物流一样被彻底分类。
+ 染料、色素、氨纶、金属等污染物可以在化学回收过程中被去除或消除。
+ 在聚合过程中可以使用不同的催化剂。目前，红土三氧化物，一种疑似致癌物，被用来加速将单体聚合成PET聚合物树脂的过程。

fashionpositive.org | info@fashionpositive.org
What currently limits recycled polyester as an input for the circular economy?

Recycled polyester made in a chemical process using plastic PET bottles or polyester clothing poses some issues for Cradle to Cradle Certified Gold-level certification. There are three main concerns.

1. PET, whether it is used in plastic water bottles or in apparel, is typically made from petrochemical sources which are non-renewable and thus not circular.

2. A hazardous chemical called antimony trioxide is used as a catalyst during the manufacture of PET resin. The PET resin is used to make both plastic bottles and virgin polyester. There have been many research studies that show that antimony trioxide has suspected carcinogenic potential for humans; any suspected or known carcinogens are unacceptable Cradle to Cradle Certified materials. Antimony may leach out of products via air and water emissions when heated. Antimony trioxide is used as a catalyst during the processing of polyethylene resin, which is then used to make polyester fiber and food grade packaging, such as water bottles. A study at the University of Heidelberg in Germany by Shotyk et al (2005)[1] showed that antimony concentrations increase in water stored on PET bottles with time. After 3 months of storage at room temperature, the antimony level increased significantly in PET bottles when compared to water stored in glass bottles. A report conducted by Westerhoff et al (2008)[2] in the U.S. tested the antimony concentration in nine commercially available bottled waters in Arizona. Initial antimony concentrations in the water were well below the USEPA maximum contaminant level (MCL) of 6 ppb. However at elevated temperatures of 60, 70 and 80°C, the exposure durations necessary to exceed the 6 ppb threshold was 176, 12 and 2.3 days respectively. Heat is used a great deal during textile manufacturing. For example, temperatures of 60°C are commonly used to pretreat, wash and rinse textile fabrics and polyester is dyed at 80 to 100°C. These elevated dyeing temperatures are the most common routes for antimony to potentially leach out of polyester fiber into wastewater.

3. Antimony may leach out of the polyester fiber and/or plastics bottle when it is landfilled or incinerated. During this process of incineration, the antimony is released as a gas and can cause problems due to its carcinogenic nature.

Unfortunately, mechanically or chemically recycled polyester made from plastic bottles or apparel contains residual amounts of antimony trioxide, thus negating the opportunity for Cradle to Cradle Certified Gold-level certification. Having toxic chemicals such as antimony trioxide in a material reduces its viability as a circular material, since recycling or reuse of that material would perpetuate the exposure to that toxic chemical.

In addition to the possible perpetuation of toxic antimony trioxide, mechanical processing of PET leads to material degradation, thus making it difficult to use the material in perpetual cycles.

The chemical recycling process offers the opportunity to get rid of the antimony trioxide from its original source (plastic bottles or post-consumer waste) and re-catalyze the PET resin with an alternative catalyst, which is not common today because antimony trioxide is cheap and a very effective catalyst.

Why was chemically recycled polyester chosen for the Call to Innovation?

Chemically recycled polyester was chosen for the Call to Innovation because of the important role polyester already plays in the apparel industry, especially in athletic apparel and for the need to open-up chemical recycling as a pathway for achieving circular fashion.

Chemically recycled polyester has some environmental benefits when compared to virgin polyester and because it is, in essence, the same as virgin polyester, it makes sense that polyester should be diverted from the landfill and used again and again with no loss in value. In addition,

1. Chemically recycled polyester can be made from post-consumer waste, thus diverting waste streams from entering the landfill.
2. Chemically recycled polyester means uses less energy and water during PET resin production.

There are a few global companies with a diverse range of innovations that address the catalyst; some innovations are in research and development and others are costly. Industry support is needed to advance chemically recycled polyester into circularity and the big need is to replace the catalyst used during the polymerization process.

What is the action plan for chemically recycled polyester through the Call to Innovation?

Fashion Positive PLUS members have identified chemical recycling as a necessary innovation for circular growth of polyester in apparel.

The group is searching for a supplier with the capability to make recycled polyester through a chemical route.

Once the chemically recycled polyester has been certified at the Gold-level, it will be added to the Fashion Positive Materials Collection.

What’s exciting about priming chemically recycled polyester as an input for the circular economy?

Recycled polyester, made through a chemical process, offers opportunities for the circular economy. Recycled polyester is growing in popularity thanks in part to brands committing to increasing recycled content in their fiber strategies. Providing an option primed for the circular economy for this popular fiber could pave the way for more fibers to follow.