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DISSOLUTION RECYCLING

ADVANCING CIRCULARITY IN AUTOMOTIVE PLASTICS

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DISSOLUTION RECYCLING

ADVANCING CIRCULARITY IN AUTOMOTIVE PLASTICS

A white paper prepared by Dissolution Recycling of Plastics Initiative (DROP-IN)

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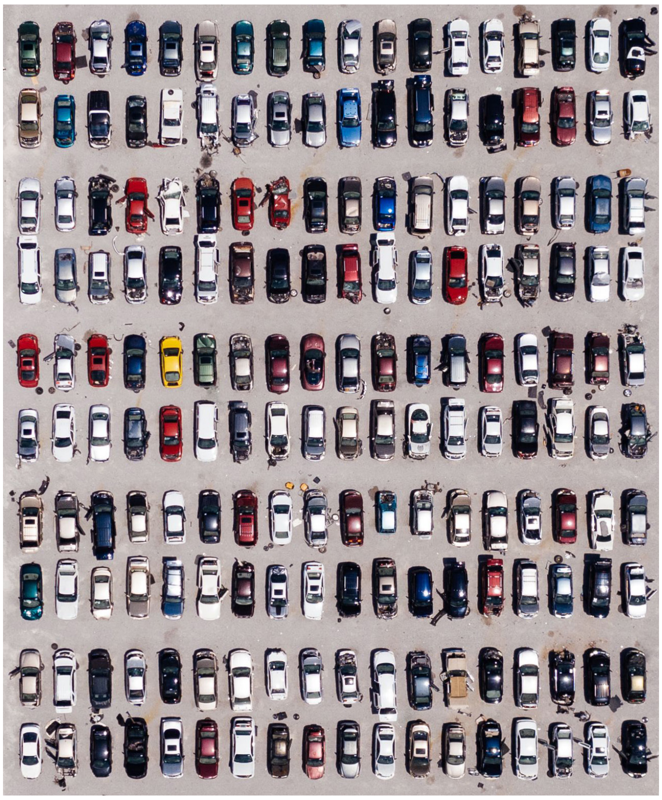

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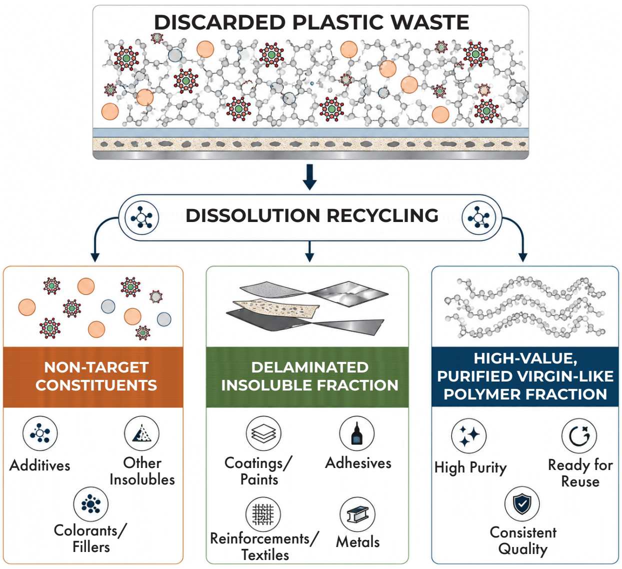
EXECUTIVE SUMMARY

About Dissolution Recycling

- Dissolution recycling is a validated and scalable technology. Pilot and industrial implementations demonstrate its ability to deliver high-quality recycled polymers from complex waste streams, responding to clear and growing market demand.
- Dissolution recycling enables the recovery of high-purity polymers beyond the limitations of conventional recycling by selectively dissolving target polymers, removing additives and contaminants, and restoring material properties to virgin-like quality.



Plastics in Automotive Industry

- Plastic materials typically account for approximately 10–20% of the total weight of a vehicle. In typical passenger cars, this corresponds to around 100–250 kg of plastics.
- Modern vehicles contain a diverse mix of plastics, dominated by PP due to its low cost, low density, and versatility. Other key polymers, including PU, PA, ABS, PC, PE, PET, PVC, and PMMA, are used across seating, interiors, lighting, fuel systems, insulation, under-the-hood parts, and structural applications.
- Automotive plastic demand is expected to continue increasing, driven by the industry's need for lightweighting, cost reduction, design flexibility, and high-performance materials across both conventional and electric vehicles.

Rising ELV Volumes and the Growing Plastic Challenge

- Around 40–41 million vehicles are estimated to become end-of-life vehicles (ELVs) globally each year, generating a rapidly growing stream of automotive plastic waste.
- Major automotive regions already face substantial ELV flows, including approximately 6.1 million ELVs annually in the EU, 10–15 million historically reported in the United States, rapidly increasing volumes in China, and around 3.4 million vehicles per year in Japan.
- As vehicle ownership and fleet turnover continue to rise, the volume of ELV plastics requiring collection, separation, recycling, or disposal is expected to increase significantly.
- The scale of the ELV plastics challenge is largely invisible in daily life, yet it is substantial. If 41 million ELVs were placed side by side, they would cover an area of around 332 km^2 which corresponds to an area larger than many major cities worldwide and with around 130 kg of plastics per vehicle, they represent more than 5 million tonnes of automotive plastics each year.

- While ELV metals are already widely recycled, plastics remain a major gap: global recycling data are not harmonized, polymer-specific tracking is limited, and in Europe only a small share of ELV plastics is currently recycled.
- Establishing effective collection, separation, recycling, and monitoring systems is therefore essential to prevent growing volumes of ELV plastics from being landfilled or incinerated and to advance true automotive circularity.

Potentially suitable for dissolution recycling
Not suitable for dissolution recycling

Upcoming Regulatory Pressure and ELV Challenge

- Regulatory and industry momentum is now building around automotive plastic circularity.
- The EU End-of-Life Vehicles Regulation was formally adopted in June 2026 and will enter into force following its publication in the Official Journal of the European Union. It requires recycled plastics to account for at least 15% of the plastic used in new vehicle types six years after entry into force, rising to 25% after ten years. At least one fifth of this recycled content must come from plastics recovered from end-of-life vehicles or from vehicle parts removed during use. This is equivalent to 3% and 5% of the total plastic content of a vehicle, respectively.
- Based on an estimated annual automotive plastics demand of 4.2 Mt, the EU's 15% and 25% recycled-content targets could increase automotive PCR demand from the current level of approximately 200 kt/year to 630 and 1,050 kt/year, respectively. This would create additional market opportunities of approximately 430 and 850 kt/year, including 126–210 kt/year of ELV-derived recycled plastics.
- In parallel, major OEMs are setting ambitious targets: BMW Group aims for 40% recycled content in thermoplastics by 2030, Ford targets 20% renewable and recycled plastics in new vehicle designs from 2025, Kia targets more than 20% recycled plastics in finished vehicles by 2030, and Volvo Cars targets at least 25% recycled or more sustainable plastics after 2025. Broader circular-material targets have also been announced by Mercedes-Benz Group, Renault Group, Stellantis, Volkswagen Group, and Toyota Motor Corporation.

Dissolution Recycling: Addressing Regulatory Pressure and Market Needs in the Automotive Industry

- Through dissolution recycling, ultra-high-purity recycled plastics derived from ELVs and other complex waste streams can be reintroduced into automotive applications. This contributes directly to the automotive industry's objectives for reducing its overall carbon footprint and moving towards a circular economy.
- By effectively removing additive history and odor-causing substances, dissolution recycling enables the production of recycled plastics suitable for high-quality and high-performance applications, including interior trim components where material purity properties are critical.
- Dissolution recycling is particularly well suited for plastic fractions that are difficult or impossible to recycle using conventional methods. This capability positions the technology as a key enabler for automotive-to-automotive plastic recycling, supporting closed-loop material flows within the sector.
- Recyclates produced via dissolution recycling require less formulation optimizations and offer a potential to reduce scrap rates during manufacturing due to consistent product quality compared to mechanical recycling.

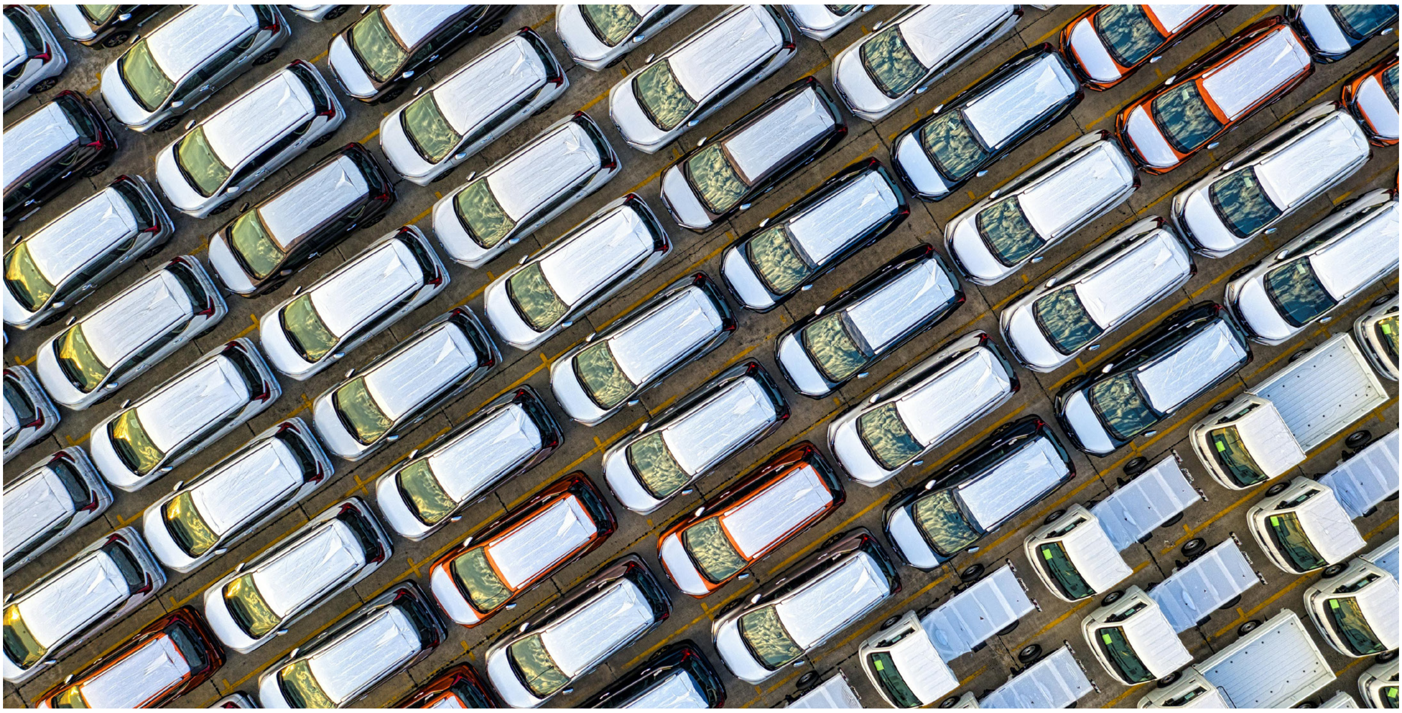
The DROP-IN Initiative

- DROP-IN is a collaborative initiative of partners those advance dissolution recycling as a trusted and scalable solution for a circular polymer economy.
- DROP-IN members strengthen confidence in the technology through scientific and technical evidence, support the development of standards and best practices, and foster a shared technical understanding across stakeholders.
- By connecting industry, academia, and investors, the initiative accelerates industrial adoption and scale-up, contributing to the recognition of dissolution recycling as a key pillar of the global circular plastics ecosystem.

Examples of Drop-In Member Activities in Automotive Applications

The examples below present some of the ongoing and potential activities of DROP-IN members in automotive applications and do not represent a complete list.

- PureCycle's PureFive® recycled polypropylene, derived from post-consumer curbside waste, was validated in a VW Atlas bumper fascia application, meeting key OEM requirements for exterior automotive components, including processability, paint adhesion, impact resistance, and weatherability.
- PureCycle and Motherson produced a near-series bumper prototype at Motherson's Tuscaloosa facility, successfully incorporating 30% PureFive® recycled polypropylene and demonstrating initial Class-A surface capability, with further climate and mechanical validation ongoing.
- ReVentas' advanced dissolution technology recovers high-purity, virgin-like PE and PP recyclates from mixed plastic waste, with demonstrated VOC reduction, strong mechanical performance, and potential for automotive reuse, including interior components where odour, emissions, and material consistency are critical.
- The TNO Möbius dissolution process, demonstrated within the ABSolEU project, recovers purified rSAN/iABS from ABS-rich end-of-life vehicle plastic waste for re-compounding into recycled ABS, enabling higher-quality applications while removing pigments, degraded rubber, fillers, additives, and other contaminants.
- Kordsa is developing dissolution recycling technologies to recover high-quality polyolefins and reinforcement materials from complex plastic waste streams. Through the Horizon Europe EcoPlast project and the TÜBİTAK SAYEM 1833 platform, the company is advancing pilot-scale recovery of polypropylene (PP), polyethylene (PE), glass fibres, and natural fibres while selectively removing fillers, pigments, and other contaminants.
- Trinseo is advancing dissolution recycling for engineering plastics through an integrated technology platform that combines feedstock qualification, polymer-specific purification, molecular property enhancement, formulation expertise, and customer qualification. Its activities include commercial polystyrene dissolution recycling, TRL 7 development of recycled polycarbonate technologies, and TRL 6 pilot-scale ABS recycling from complex waste streams, supporting the production of application-ready engineering plastics incorporating recycled content for demanding applications such as automotive.
- Polyloop uses selective dissolution to recover PVC, PC, PVB, and PVDF from complex automotive streams, enabling separation from metals, fabrics, glass, and battery materials while retaining plasticizers and fillers in the recovered compound.
- Oligomaster is developing an integrated recycling approach for automotive seat covers by combining PVC dissolution recycling with chemical recycling of polyurethane foam. The PVC recycling route is being developed in collaboration with PolyLoop. Validation studies have demonstrated effective separation of PVC, textiles, and foam, producing recycled PVC suitable for further processing and PU foam for conversion into recycled polyols. This approach supports higher-value recovery and circularity in automotive seating.



INTRODUCTION

The automotive industry is facing increasing pressure to transition from a linear material model to a more circular material system, driven by sustainability targets, forthcoming stricter end-of-life vehicle (ELV) regulations, and growing demand for high-performance recycled plastics. However, there is currently a gap between the quality and quantity of recycled materials needed to enable this transition and the capacity and capabilities of existing solutions. Conventional recycling technologies alone are not sufficient to fully support the automotive industry's transition to a circular material model. This creates a clear need for innovative recycling technologies that can complement conventional approaches, close existing material-quality gaps, and support the automotive sector's transition toward circularity. Dissolution recycling emerges as a promising candidate to address a critical part of this gap by enabling the recovery of higher-quality and more consistent polymer streams from complex automotive plastic waste.

Dissolution recycling offers a complementary and transformative pathway by selectively dissolving target polymers, removing additives and contaminants, and restoring material quality close to virgin levels. Dissolution recycling offers a dual contribution to the automotive industry by both enabling the recovery and reuse of plastics from end-of-life vehicles within automotive applications and providing access to ultra-high-purity recycled plastics from non-automotive waste streams. While mechanical plastics recycling remains essential, dissolution recycling is necessary to enable true circularity in the automotive industry by addressing the inherent limitations of conventional mechanical recycling.

This white paper aims to introduce dissolution recycling technology to the automotive sector and demonstrate how it can help address critical gaps in the transition towards circular material use. It begins by assessing the role and current status of plastics in the automotive industry and addresses the challenges posed by end-of-life vehicles (ELVs), the growing plastic waste problem, and the need for circular solutions. The paper further reviews recent global regulatory developments and presents examples of contributions and activities by members of the Dissolution Recycling of Plastics Initiative (DROP-IN) in the automotive domain.

PLASTICS IN AUTOMOTIVE INDUSTRY

As the automotive industry emerged before the modern plastics industry, early vehicles relied primarily on traditional materials such as textiles, leather, wood, glass, and metals. Over time, many of these materials have been gradually replaced by plastic alternatives. In modern vehicles, plastics are used not only for design flexibility and aesthetic purposes, but also for their functional advantages, such as weight reduction, corrosion resistance, manufacturing efficiency, and cost-effectiveness. This transition has also reshaped the material composition of critical functional components, including interior parts ranging from carpets to headliners, as well as exterior components such as bumpers and lighting systems. Driven by these advantages, plastics have become indispensable to the automotive industry and now play a central role in vehicle design, performance, and manufacturing.

As the industry continues to focus on improving vehicle performance, especially on reducing mass in electric vehicles to extend driving range, the role of plastics is becoming even more significant. Currently, plastics account for approximately 10–20% of a vehicle's total weight. This share is expected to grow in the future, as plastics play a key role in lightweighting strategies and the development of next-generation vehicles.

Figure 1. Plastic applications in automotive components. Material selection may vary depending on manufacturer, vehicle model, component design, and performance requirements.

A schematic overview of plastic components used in a modern automobile is presented in Figure 1. A wide range of plastic materials is utilized in modern vehicles, with polypropylene (PP) being the most dominant polymer owing to its low cost, low density, and strong chemical resistance. Depending on the vehicle's price range, PP is extensively used in components such as bumpers, lead acid battery housings, interior trim elements, and various under-the-hood parts. Polyurethane (PU) also plays a significant role, particularly in flexible foam applications including seat cushioning, headrests, and thermal or acoustic insulation, where comfort and insulation performance are essential. In applications that demand enhanced mechanical strength, impact resistance, and thermal stability, engineering plastics such as polyamide (PA), acrylonitrile–butadiene–styrene (ABS), and polycarbonate (PC) are commonly selected. Particularly in the higher-price-segment range vehicles ABS and PC are used in many interior applications and selected over PP. These mid-range engineering thermoplastic materials are typically found in structural components, dashboard systems, pillar trim, overhead consoles, safety-critical parts, and lighting assemblies. Polyethylene (PE) is mainly used in fuel tanks, underbody coatings, cable insulation, and containers for various automotive fluids. Poly(ethylene terephthalate) (PET) is widely applied in textile-based components such as seat fabrics and carpets, as well as in selected under-the-hood applications and structural reinforcements. Finally, poly(vinyl chloride) (PVC) is employed in cable insulation, interior trim elements, and underbody coatings due to its durability and inherent flame-retardant properties, while poly(methyl methacrylate) (PMMA) is commonly used in rear lighting and tailgate components and some decorative features such as bezels and light guides. Their extensive use reflects the advantages plastics offer in terms of light weighting, design flexibility, and cost efficiency.

According to *V. K. Soo et al.*, the average weight of a modern lightweight electric vehicle (EV) is approximately 1,744 kg, of which around 128 kg consists of plastic materials. In comparison, an internal combustion engine (ICE) vehicle has an average weight of 1,298 kg, with a reported plastic content of 139 kg [1]. These figures highlight the significant and persistent role of plastics in both conventional and electrified vehicles. In a complementary study, *A. Arca et al.* analyzed the average weight distribution of plastic components in automobiles. The corresponding plastic types and their weight contributions across different vehicle parts are summarized in Table 1 [2].

Table 1. Typical automotive plastic components (Adapted from *Arca et. al.* [2])

Automotive Plastic Components	Weight (kg)	Polymer Types
Airbag	1.1	PA
Seatbelts	1.8	PET
Door panel	3	PP
Bumper	6.5 - 20	PP, ABS, PC, PE
Seats	10.2 - 20 1.7	PU, PVC, PA, ABS PP
Fuel Tank	6 - 10	HDPE, PE, POM, PA, PP
Interior and exterior trims	Interior: 20 - 40 Exterior: 4	POM, PP, ABS, PET, PVC, PA
Dashboard	7 - 20	PP, ABS, PE, PC

ELV PLASTICS AND THE GROWING WASTE CHALLENGE

An end-of-life vehicle (ELV) is a vehicle that has reached the end of its useful life and has entered the waste management system for dismantling, treatment, reuse, recycling, or disposal. Importantly, not every deregistered, old, or damaged vehicle should automatically be classified as an ELV, as some may be exported as used vehicles, repaired and returned to service, or retained in private ownership. Therefore, determining or accurately estimating the actual number of ELVs remains challenging under the current reporting and tracking systems. Despite these uncertainties, reliable estimates are still needed to understand the scale, environmental significance, and future growth of the ELV problem. Quantification is also important for planning treatment capacity, assessing material recovery potential, and developing effective circular economy policies. For this reason, this section reviews figures reported in the scientific literature, institutional reports, and industry sources in order to provide an approximate overview of ELV generation and processing at the global and regional levels.

Globally, approximately 40-41 million vehicles are estimated to reach the end of their service life and become end-of-life vehicles (ELVs) each year, according to multiple sources [3,4].

The European Union generates approximately 6.1 million end-of-life vehicles (ELVs) annually, corresponding to a total vehicle mass of around 6.7 million tonnes. Based on an average plastic content of approximately 12% and broader estimates from the European Commission's Joint Research Centre (JRC), the EU ELV stream is estimated to generate approximately 0.8–1.0 million tonnes of plastic waste each year [5].

In the United States, no recent data on the annual number of end-of-life vehicles (ELVs) could be identified. However, a study published in 2010 reported that approximately 10–15 million vehicles were sent to automotive recycling facilities each year [6]. Considering the subsequent growth of the vehicle fleet, it is reasonable to assume that the United States currently generates at least a comparable number of ELVs annually.

In China, earlier literature indicates approximately 2.295 million ELVs in 2019, including about 1.951 million automobiles [7]. More recent reports, based on a different reporting scope and year, indicate a substantially larger processing scale, with China processing more than 7.9 million ELVs in 2024 and approximately 8.4 million vehicles in the first ten months of 2025 [8]. Based on an estimated 150–200 kg of plastic per vehicle, China's ELV stream is reported to generate approximately 1.2–1.6 million tonnes of plastic waste annually [8].

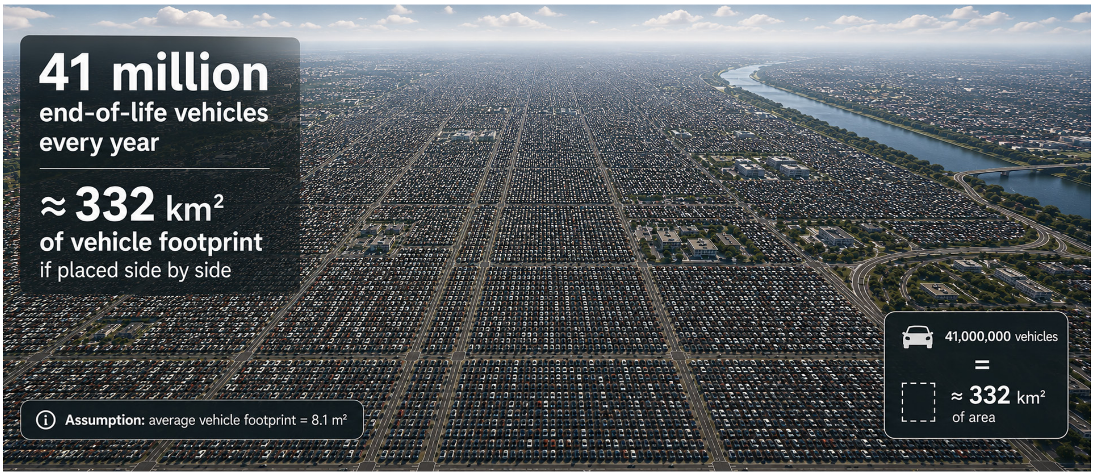
In Japan, the average annual number of end-of-life vehicles is approximately 3.4 million units. In 2019 alone, 3.36 million ELVs were recorded, reflecting a relatively stable yet consistently high level of vehicle retirement within a mature automotive market [6]. In addition, during the 2020 fiscal year, approximately 3.15 million end-of-life vehicles were reported also in Japan [9].

In South Korea, 696,915 end-of-life vehicles were reported in 2019. The study estimated that approximately 26,600 tonnes of end-of-life vehicle plastics were generated from separately identified plastic-containing components, corresponding to about 2.6% of the total ELV weight and therefore not representing the full plastic content of each vehicle. Within this reported ELVP stream, tires represented the largest fraction at 34.9%; among plastic vehicle components, bumpers accounted for 27.2%, followed by seat foam materials at 24.5%, synthetic resin components at 7.5%, and fuel tanks at 5.9% [10].

As these figures indicate, ELVs are generated in very substantial quantities worldwide. With continued economic growth, rising vehicle ownership, and the expansion of the global vehicle fleet, the number of vehicles reaching the end of their service life is expected to continue increasing in the coming years. This growth also increases the scale of the plastic waste challenge associated with ELVs, as larger numbers of end-of-life vehicles translate into greater volumes of automotive plastics requiring collection, separation, recycling, or disposal.

SCALE OF THE PROBLEM AND NEED FOR ADVANCED RECYCLING TECHNOLOGIES

Unlike household waste, end-of-life vehicles are not usually visible in our daily lives. As a result, the true scale of the ELV waste challenge may not be readily apparent in everyday life. However, if each vehicle is assumed to occupy an average footprint of approximately 8.1 m², 41 million ELVs placed side by side would cover an area of around 332 km² which corresponds to an area larger than many major cities worldwide. The fact that such a volume of waste is generated every year clearly illustrates the magnitude of the ELV challenge.



Metals contained in ELVs are already recycled to a large extent, and the recycling infrastructure for metallic fractions is relatively well established. However, significant gaps remain in the recovery and recycling of plastics from ELVs. Assuming that each vehicle contains approximately 130 kg of plastics, 41 million ELVs would correspond to around 5.33 million tonnes of automotive plastics annually. If these plastics are not properly recovered, they may either occupy substantial landfill space or be incinerated. Based on an estimated incineration impact of approximately 2.73 kg CO_2-eq per kg of plastic [11], the plastics contained in annual ELV generation could represent a potential climate impact of approximately 14.6 million tonnes CO_2-eq per year if incinerated.

To prevent this potential environmental impact from becoming a reality, and to minimize the risks associated with the growing volume of ELV plastics, effective recycling practices must be systematically applied to these materials. However, existing approaches to the collection, separation, and recycling of plastics from end-of-life vehicles remain insufficient to address the scale and complexity of the problem.

A reliable global estimate of ELV plastic recycling is not yet available because countries use different definitions, reporting systems, and treatment practices. In many regions, ELV plastics are not tracked separately, and informal dismantling, used-vehicle exports, and inconsistent reporting of recycling, energy recovery, and disposal further reduce data quality. A common global monitoring system and standardized methodology are therefore needed to measure ELV plastic flows accurately and track progress toward automotive circularity. Europe is relatively advanced in ELV regulation, monitoring, and reporting compared with many other regions. However, even within Europe, harmonized and polymer-specific data on ELV plastic recycling remain limited. In Europe, despite this significant recovery potential, only approximately 9–15% of collected plastics from end-of-life vehicles are currently recycled, while more than 75% are directed to disposal routes, including landfill and energy recovery [5].

REGULATORY REQUIREMENTS AND INDUSTRY COMMITMENTS

To address this growing challenge, a range of regulatory and industry-led actions has begun to emerge. In Europe, the new EU End-of-Life Vehicles Regulation has moved from proposal to formal adoption: it received the green light from the European Parliament on 18 June 2026 and was formally adopted by the Council on 29 June 2026. The regulation will enter into force after publication in the Official Journal of the European Union, with its provisions generally applying 24 months later. For plastics, it introduces recycled-content targets for new vehicle types: at least 15% recycled plastic six years after entry into force and 25% after ten years. At least one fifth of this recycled plastic content must be recovered from end-of-life vehicles, corresponding to 3% and 5% of total plastic content, respectively.

In parallel with these regulatory developments, several automotive manufacturers have announced their own recycled and sustainable material targets and they are summarized in Table 2. Beyond these examples, many other vehicle manufacturers have introduced similarly ambitious commitments. As these commitments demonstrate, the automotive industry is increasingly pursuing sustainability ambitions that go beyond minimum regulatory requirements.

Table 2: Recycling and sustainability commitments of automotive manufacturers compiled from publicly available information

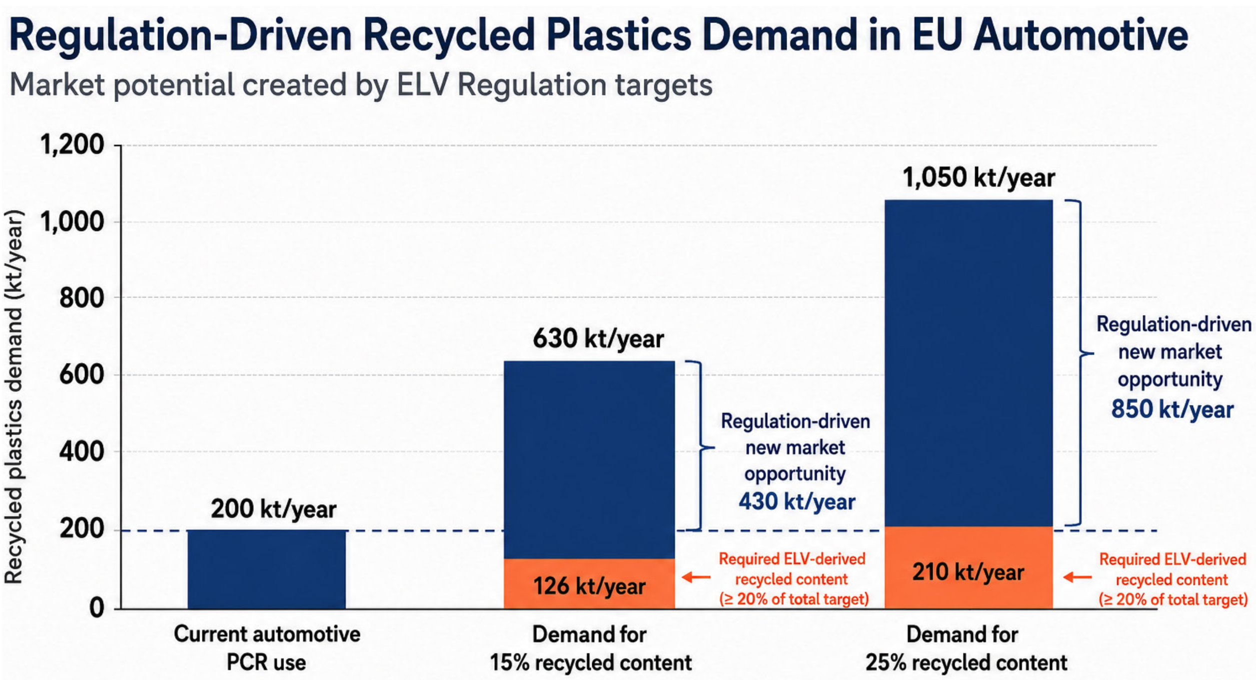
OEM	Target
BMW Group	Increase recycled content in the thermoplastics used in new vehicles from around 20% to an average of 40% by 2030 [13]
Ford Motor Company	20% renewable and recycled plastics in new vehicle designs from 2025 in North America, Europe, and Türkiye [14]
JLR - Jaguar Land Rover	Achieving net-zero carbon emissions by 2039 across their entire supply chain, products, and operations [15]
Kia – Hyundai Motor Group	Kia targets more than 20% recycled plastics in finished vehicles by 2030. Hyundai Motor Company also reports car-to-car recycling initiatives [16]
Mercedes-Benz Group	Increase the share of recycled and secondary raw materials in the passenger-car fleet to an average of 40% by 2030 [17]
Renault Group	Incorporate 33% recycled or circular-economy materials by weight in new vehicles by 2030. The target covers all vehicle materials and is not specific to plastics [18]
Stellantis	Green materials to account for 35% of total vehicle weight in all new models launched by 2030 [19]
Volkswagen Group	Aims to use 40% circular materials in passenger cars and light commercial vehicles entering production from 2040 onward, excluding China [20]
Volvo Cars	Target of using at least 25% recycled or more sustainable plastics in its vehicles after 2025 [21]
Toyota Motor Corporation	Aim to use 30% or more recycled materials on average in new models introduced after 2030, measured on a vehicle-weight basis. This is a broad recycled-material target and is not specific to plastics [22]

Note: The table includes publicly available recycled-content, circularity, and broader sustainability commitments. Where specific recycled-plastics targets were not identified, broader material or carbon-related commitments are reported.

Regulation-Driven Market Opportunity for Automotive-Grade Recyclates

The implementation of the EU recycled-content requirements, together with the voluntary sustainability commitments of automotive manufacturers, is expected to significantly increase the demand for automotive-grade recycled plastics. According to Plastics Europe (2024), the European automotive sector currently consumes approximately 200 kt/year of post-consumer recycled (PCR) plastics [12]. This value can be considered the current baseline for the automotive-grade PCR market. The introduction of the EU recycled-content requirements will substantially expand this market. Based on the Joint Research Centre (JRC) assessment, the European automotive industry is expected to consume approximately 4.2 million tonnes of plastics annually over the coming years [5]. Applying the proposed recycled-content targets to this demand indicates that a 15% recycled-content requirement would create a total demand of approximately 630 kt/year of PCR plastics. Compared with the current market size of approximately 200 kt/year, this corresponds to an additional 430 kt/year regulation-driven market opportunity. Furthermore, under the proposed regulation, at least 20% of the required recycled content must originate from end-of-life vehicles (ELVs). Accordingly, approximately 126 kt/year of the total 630 kt/year demand would need to consist of ELV-derived recycled plastics recovered and reintroduced into new automotive applications. Following the full implementation of the regulation, the recycled-content requirement will increase to 25%, raising the total demand for automotive-grade PCR plastics to approximately 1,050 kt/year. Compared with the current market, this represents an additional market opportunity of approximately 850 kt/year. Under the same regulatory provisions, at least 20% of the required recycled content must continue to originate from ELVs, corresponding to approximately 210 kt/year of ELV-derived recycled plastics.

This analysis indicates that the European automotive market has substantial potential for growth in the use of recycled plastics. Dissolution recycling can play an important role in supporting this expansion by producing high-purity recyclates capable of meeting demanding automotive quality requirements. To explain this potential in greater detail, the following sections provide an overview of the fundamental principles of dissolution recycling and present selected application examples from DROP-IN members.

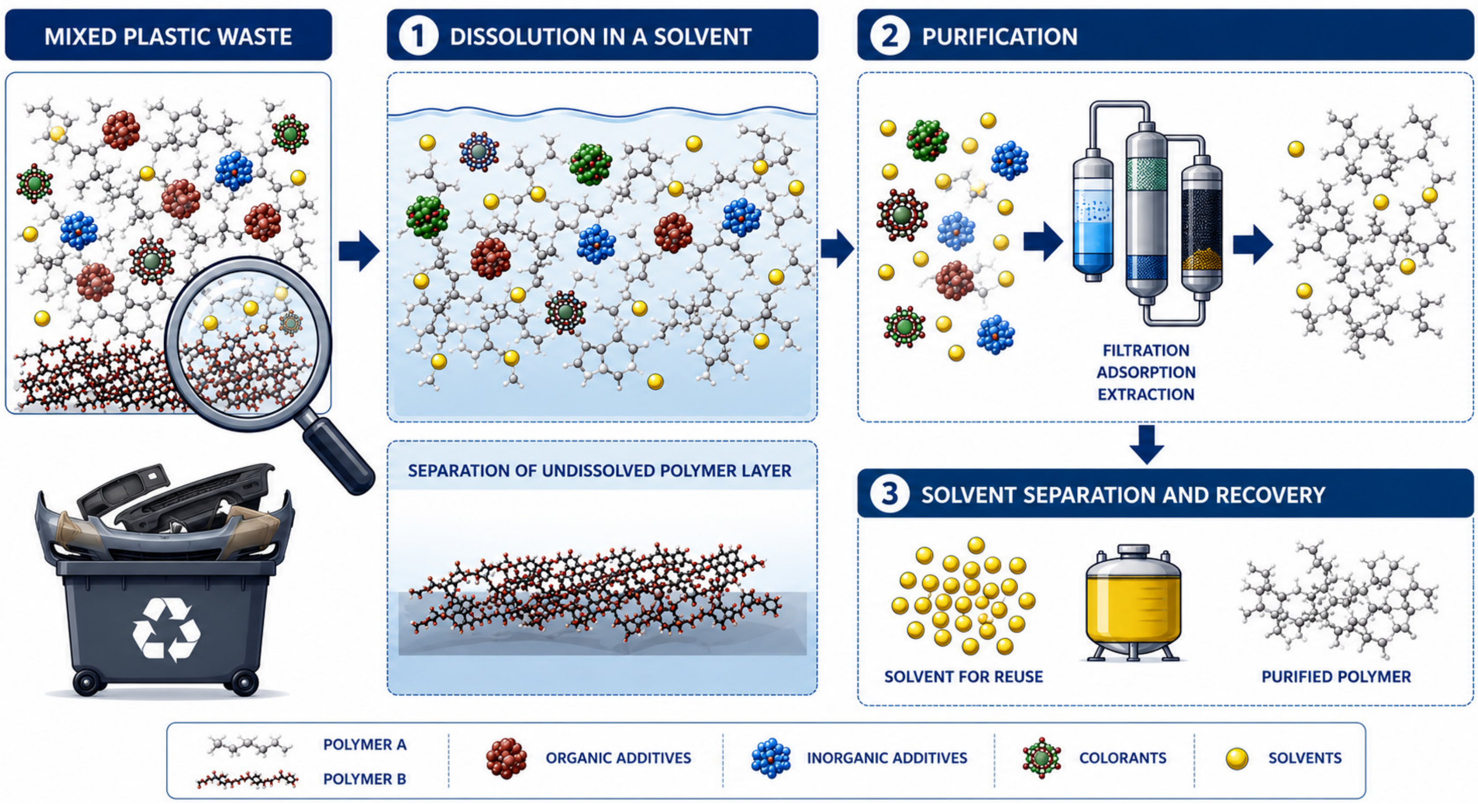


DISSOLUTION RECYCLING AND ITS BENEFITS FOR THE AUTOMOTIVE INDUSTRY

In dissolution recycling, the target polymer (e.g., PE, PP, PS, PA, PC, PVC, PET) is first selectively dissolved in an appropriate solvent to form a homogeneous solution. Organic additives, inorganic fillers, pigments, and other polymers typically remain undissolved. The insoluble nature of these unwanted components enables their removal through physical separation methods.

For example, in multilayer or laminated plastic structures containing two or more polymers, the selectively dissolved polymer can be efficiently separated from non-target materials. In addition, dissolved-phase impurities such as residual additives and colorants can be removed using purification techniques including filtration, adsorption, or extraction, enabling further improvement in polymer purity.

Polymer recovery may be achieved either by antisolvent precipitation or by direct devolatilization of the polymer solution. In direct devolatilization, solvent removal may induce phase separation or solidification; however, the process is generally classified as devolatilization rather than precipitation. Depending on the solvent system and process design, polymer recovery may involve temperature-induced phase separation, the addition of a nonsolvent, or evaporation-based solvent removal. As a result, the polymer can be recovered in a purified form with properties close to virgin material quality, while the solvent can be recovered and reused within the process, supporting both economic and environmental sustainability.



Potentially suitable for dissolution recycling

Not suitable for dissolution recycling

One of the main barriers to the reuse of plastics in the automotive sector is the presence of additives, which may act as impurities during secondary use and negatively affect mechanical and aesthetic properties. Accumulated additive history often leads to inconsistent performance, limiting the use of recycled plastics in high-value applications. Dissolution recycling can remove this additive history by separating polymers from additives, pigments, and other contaminants, enabling material properties comparable to virgin plastics and improving the reuse potential of ELV plastics.

The key benefits of dissolution recycling (DR) for the automotive industry can be summarized as follows:

- Enables the production of high-quality recyclates from major polymer families and blends, including polyolefins (PP, PE), vinyl polymers such as PVC, styrenics (PS, ABS, SAN), engineering thermoplastics and blends (PC, PMMA, PC/ABS), and selected polyesters (PET), supporting their reuse in demanding applications where consistent mechanical performance, aesthetics, and processability are required.
- Removes legacy additives, pigments, flame retardants, and other contaminants from polymer streams, improving recyclate purity, material quality, and suitability for closed-loop applications.
- Supports recycling of polymers that are difficult to recycle mechanically due to contamination, additives, coatings, or polymer incompatibility, thereby increasing overall material recovery rates.
- Facilitates the selective separation and recovery of individual polymers from complex mixed-plastic assemblies and multi-material products, including engineering plastic blends and composites.
- Provides manufacturers and compounders with purified recycled polymers that can be reformulated for specific end-use requirements, enabling greater consistency, performance, and design flexibility across multiple polymer families.
- Helps overcome typical repainting limitations associated with mechanically recycled plastics, as purified polymers with reduced additive and contamination history enable improved surface quality and paintability.

DROP-IN INITIATIVE AND EXAMPLES OF MEMBER ACTIVITIES IN AUTOMOTIVE APPLICATIONS

Dissolution Recycling of Plastics Initiative (DROP-IN) is a collaborative initiative dedicated to advancing dissolution recycling as a credible and scalable solution for a circular polymer economy. The initiative contributes to strengthening confidence in the technology by promoting scientific and technical understanding, supporting the development of common standards, and facilitating the exchange of best practices across stakeholders. By bringing together industry, academia, and investors, DROP-IN helps create a shared knowledge base and supports the conditions needed for industrial adoption and scale-up. Through these efforts, the initiative contributes to the gradual recognition of dissolution recycling as a complementary pathway within the broader circular plastics landscape.

The DROP-IN initiative consists of both Core Members and Associate Members. Core Members primarily include technology companies actively developing or implementing dissolution recycling solutions, although membership is not strictly limited to these organizations. Associate Members mainly represent stakeholders from across the plastics value chain, including companies using recycled materials, technology providers, engineering firms, and other relevant industry participants. Together, these members contribute to the development, validation, and broader adoption of dissolution recycling technologies.

Membership in the DROP-IN Initiative is open to all interested stakeholders across the dissolution recycling value chain. This includes dissolution recyclers, engineering companies, inventors, technology developers and providers, waste managers and sorters supplying suitable feedstock, converters and brands using dissolution recycled content, as well as R&D institutions such as universities and research organizations. Associations and other organizations that support the advancement of dissolution recycling are also welcome to participate.

In the following sections, some examples of activities carried out by DROP-IN members in the automotive and ELV sectors are presented. These examples are provided for illustration purposes and do not represent the full scope of ongoing activities, but rather aim to highlight current developments and demonstrate the potential of dissolution recycling in addressing key challenges within these application areas.

PURECYCLE

PureCycle's PureFive® rPP in Automotive Applications

Conventional recycling methods may produce recyclates with performance limitations for demanding automotive applications. PureCycle's purification process is designed to increase the purity of polypropylene in PureFive® resin by removing contaminants that can reduce material performance. Compounding expertise is also provided to tailor the material properties required for large-moulded parts and textile applications. In addition, PureCycle has announced a global expansion plan intended to support growing demand and future compliance with ELV-related recycled-content requirements.

PureFive® rPP with Volkswagen

PureCycle's dissolution recycling process has demonstrated the ability to produce recycled polypropylene from post-consumer curbside waste that meets the demanding performance requirements of exterior automotive applications. At the TPO 2025 Global Automotive Conference, PureCycle showcased how its dissolution recycling process enabled high-quality recycled PP for a VW Atlas bumper fascia. These fascias made with PureFive® are not yet in commercial production.

Dr. Mahshid M. Nejad, Sustainable Materials Engineer, and Dr. William Henken, Sustainable Materials Engineer, at Volkswagen Group of America Inc. – Innovation Hub Knoxville, initiated the project with PureCycle to explore sustainable material innovations. 100% of the polypropylene used in the compound for the bumper fascia is recycled PureFive® resin.

To qualify PureFive® resin for an exterior structural component of this kind, the material passed all of the rigorous OEM-specified tests: injection molding processability trials to confirm consistent flow, shrinkage, and dimensional stability across production runs; paint adhesion testing to confirm that coatings bond uniformly to the substrate without delamination or bubbling; low-temperature and high-speed impact testing to validate that the fascia can absorb collision energy without cracking or shattering; and weatherability testing to ensure the part holds its structural integrity and appearance over the vehicle's service life.

The fact that PureFive® resin, derived from post-consumer waste that would otherwise be landfilled, can clear these hurdles is a direct result of PureCycle's unique dissolution process, which removes contaminants, odors, and degradation byproducts to restore the polymer to virgin-like performance.

Fully Assembled VW Atlas Bumper with PureFive® Resin

THE BENEFITS OF OUR PUREFIVE® RESIN FOR AUTOMOTIVE

LOW ODOR
PureCycle's process removes the odor commonly associated with mechanical recycling making it ideal for interior applications

PAINT ADHESION
Low PE and ash content levels allow PureFive® resin to perform similar to virgin PP

FULLY CIRCULAR
Opportunity to partner with PureCycle to recycle your car parts

VERSATILITY
PureFive® resin can be used to produce exterior and interior parts, including textile applications

SUSTAINABILITY
Lower energy usage and fewer carbon emissions compared to virgin PP production

PCR CONTENT
PureFive® resin is produced from post-consumer curbside waste

PureFive® rPP with Motherson

PureCycle and Motherson are advancing the use of recycled polypropylene in automotive components through the production of a near-series bumper prototype. Manufactured at Motherson's Tuscaloosa facility in the United States and coordinated by its R&D team in Bötzingen, Germany, the prototype successfully incorporated 30% PureFive® recycled polypropylene and demonstrated initial Class-A surface capability. Further testing is ongoing, including constant condensation climate testing according to DIN EN ISO 6270-2 (CH) and mechanical property evaluation.

About PureCycle

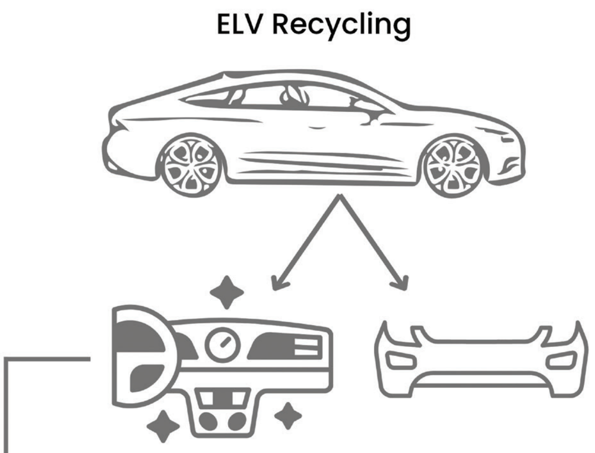
PureCycle is advancing polypropylene (PP) recycling by transforming PP plastic waste into a circular resource through its patented dissolution recycling process. By selectively dissolving the PP, the process removes odour, colour, non-PP plastics, and other impurities from the recycled material, leaving behind a like-new plastic.

For more information: https://purecycle.com/contact

ReVentas' Dissolution Technology

Automotive recyclate material recovered from end-of-life vehicles (ELVs) typically contains high filler and additive content, such as glass fibres, rubber and talc. Alongside this, ELV sources also contain legacy additives and banned chemicals, such as lead stabilisers, brominated flame retardants and phthalates. Such additives and fillers have created a longstanding challenge in mechanical recycling, where removal is difficult, which makes the product difficult to return to the market, resulting in ELV waste often being incinerated. Residual contaminants, if not sufficiently removed, can also result in recyclate with properties far below those of virgin polymers. To meet the European ELV Regulation requirements, automotive manufacturers must incorporate specified amounts of recyclate into their automotive components. Initially, this can be met with post-consumer recyclate however, by 2032 this must be partially met through closed-loop ELV-to-ELV streams.

ReVentas' advanced dissolution technology can provide the solution to this, addressing the growing global challenge of plastic waste and the need for high-quality plastic recyclate. The technology works by selectively dissolving polyethylene or polypropylene from a mixed waste stream, filtering it through a specialised filtration train and producing high-quality virgin-like polymer recyclate (Figure 2). The filtration train is tailored to achieve high product purity, removing large contaminants (such as undesirable polymers, dirt, dust, fibres), insoluble contaminants (including pigments, fillers, additives) and soluble contaminants (such as inks, volatile organic compounds (VOCs)). Figure 1 presents the stages of the ReVentas process, illustrating the progression from the initial flake feedstock to the polymer solution before and after filtration, followed by the resulting polymer powder and a melted specimen of the powder.



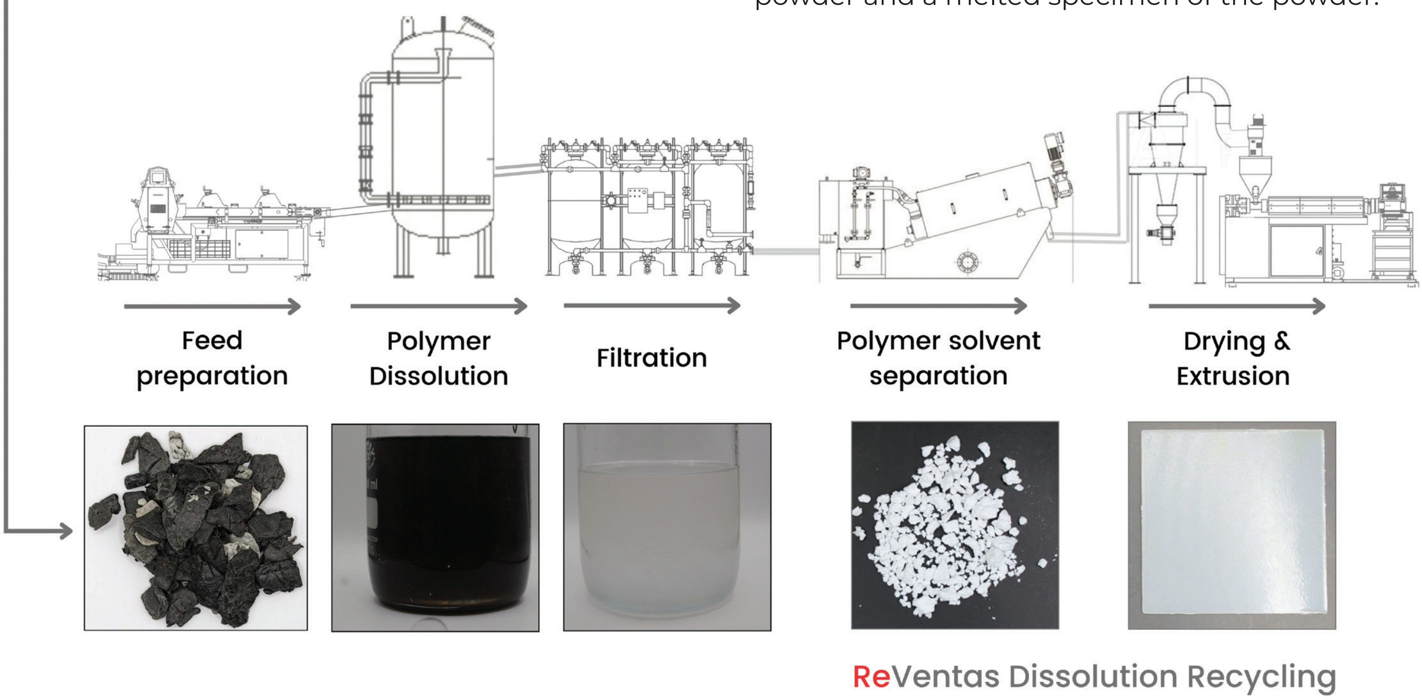


Figure 2. Schematic to show ReVentas dissolution recycling technology.

The output polymer has shown enhanced tensile strength, strong impact performance and promising overall mechanical properties. While odour removal remains one of the greatest challenges for mechanically recycled ELVs, ReVentas' technology has demonstrated a significant reduction in VOCs across a wide range of feedstocks. ReVentas are working alongside an automotive parts manufacturer to demonstrate VOC removal to within safe limits for automotive reuse, notably for interior components. A challenge test was also completed to demonstrate the decontamination efficiency of the ReVentas technology. A range of surrogates, chosen to mimic real-world chemicals and contaminants, were dosed into a polypropylene sample in high concentrations. After the ReVentas dissolution technology, the output product showed almost complete removal efficiency across 11 chemicals (see results below; Table 3).

Due to the low contamination levels in the final product, processability of the recycled polymer improves significantly, making parts manufacturing significantly easier, compared to mechanical recyclate. The paintability behaviour is also expected to be similar to virgin resins, due to a reduction in surface defects on the polymer.

By restoring polymer properties to virgin-grade and using a technology that operates at low pressures and temperatures, the ReVentas process has demonstrated how its low carbon footprint could reduce the reliance on fossil-based virgin plastics, to meet the needs of the automotive industry.

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Table 3: Decontamination efficiency of the ReVentas process during a PP challenge test.

Surrogate	Input [mg/kg]	Average [mg/kg]	Decontamination
Methylcyclohexane	1117	0	100%
Toluene	436	0	100%
Chlorobenzene	775	0	100%
Chlorohexane	1233	0	100%
Phenylcyclohexane	4303	74.7	98%
Benzophenone	2280	54.6	95%
Laurolactam	476	1.4	100%
Ethyl palmitate	2009	98	95%
Methyl stearate	2125	108.7	95%
Vitamin E	1449	0.4	100%
SAIB	390	0	100%

End of Life Vehicle ABS Waste Recycling by the TNO Möbius Dissolution Technology

The dissolution of end of life vehicle (ELV) plastic waste—particularly ABS-containing streams—is a physical recycling process based on selective solubility of SAN. In the context of the ABSolEU project [23], the technology is implemented via the TNO Möbius process, which is designed to recover high value polymer fractions from complex waste streams, including polyolefins, styrenics and polycarbonate.

1. Feedstock Preparation and Selective Dissolution

In the process, ELV plastic waste is first pretreated through dismantling, sorting, washing, and shredding into pre-sorted streams with relatively controlled particle size (flakes/shreds). The resulting ABS-rich fraction (waste ABS, wABS) is introduced into a closed dissolution reactor where it is contacted with a carefully selected solvent (in this case ethyl acetate). Under elevated temperature, pressure, and agitation, the solvent selectively dissolves the target polymer phase—primarily the styrene–acrylonitrile (SAN) component of ABS—while leaving behind non-soluble fractions such as fillers, metals, other polymers, and degraded rubber phases.

This selective dissolution step is fundamental. As stated before: it is not a chemical reaction but a physical separation process, enabling high-quality polymer recovery without breaking polymer chains or altering chemical composition.

2. Solid–Liquid Separation and Purification

Once dissolution is achieved, the resulting polymer solution contains dissolved SAN together with suspended insoluble contaminants such as polybutadiene rubber (PBR), pigments, and mineral fillers. The process employs multi-

stage filtration (coarse and fine filtration, often employing sorption materials and filter aids) to remove these impurities.

This purification stage is critical for achieving high polymer quality: degraded rubber particles and additives are efficiently separated, preventing contamination of the final recycled polymer. The use of various filtration options enables handling of viscous, particle-laden streams typical for ELV plastics.

3. Polymer Recovery Via Precipitation

Following purification, the clean polymer solution is sent to a precipitation step. In the present lab-scale process (TRL5), the solution is introduced into a miscible non-solvent, which reduces polymer solubility and induces controlled precipitation of the dissolved SAN polymer.

The polymer separates as a solid (powder or granulate), while impurities that remained soluble in the solvent/antisolvent mixture stay in the liquid phase. The recovered intermediate product (intermediate ABS, iABS, or recycled SAN, rSAN) is thus substantially purified, free from many of the contaminants present in the original ELV waste, where the choice for low-boiling solvents and mild conditions throughout the processing limit any product degradation. Note that in a future industrial setup the aim is to work with a single-solvent configuration, where the polymer product can be recovered by evaporation of the solvent (e.g. spray drying).

4. Solvent Recovery and Process Closure

A key aspect of dissolution recycling is solvent circularity. The TNO Möbius dissolution process incorporates a solvent recovery module where solvents and antisolvents are separated (typically by evaporation and condensation under controlled conditions) and reused.

Solvent recovery significantly reduces operational costs and environmental impact, enabling a closed-loop solvent system. The non-reactive nature of the process (purely physical phase changes) also minimizes the formation of by-products, distinguishing it from chemical recycling routes such as depolymerization or pyrolysis.

5. Outcomes and Material Valorization

The main outcome of the dissolution process applied to ELV waste is the recovery of high-purity polymer intermediates—specifically recycled SAN (rSAN or iABS)—that can be re-compounded into recycled ABS (rABS), as was shown for fully functional shaver handles. Examples of the input and output materials are given in the pictures below [23].

Compared to mechanical recycling, this approach delivers improved material quality by removing pigments and dyes, additives, degraded rubber, and contaminants that would otherwise accumulate and degrade properties. The resulting polymers are suitable for higher-value applications, thus supporting circularity in automotive plastics. Additionally, the separation of impurity streams (e.g. fillers, rubber fractions) opens pathways for further valorization or safe disposal. Overall, dissolution recycling enables recovery of functional polymer building blocks from complex ELV waste streams that are otherwise largely incinerated or landfilled.

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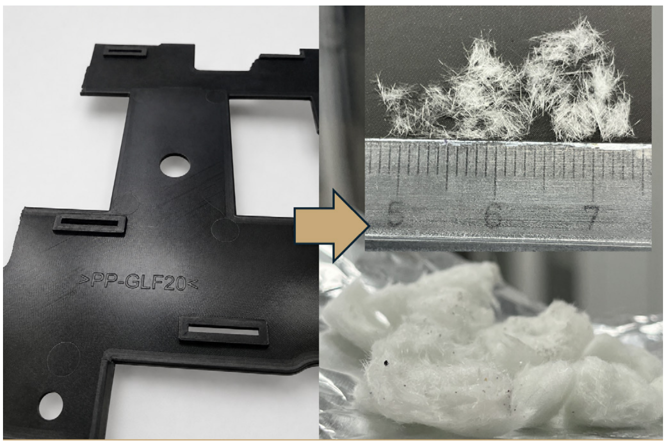
Kordsa's Dissolution Recycling Activities in Automotive Plastics

Kordsa is a global player in the material technologies market with strong expertise in tire reinforcement and composite solutions. Building on its materials know-how and innovation capabilities, the company is expanding its activities toward sustainable material solutions, recycled plastics, and circular applications across multiple sectors. In this context, Kordsa is developing dissolution recycling technology for polyolefin-based plastic waste streams, with the aim of recovering high-quality polymer fractions and valuable reinforcement materials for reuse in higher-value applications. This section presents two projects conducted as part of these activities, with a focus on their relevance to the automotive plastics industry and their potential contribution to circular material solutions.

EcoPlast Project

EcoPlast is a Horizon Europe Innovation Action project designed to strengthen circularity across the automotive plastics value chain. Bringing together 18 partners and 9 industrial use cases, the project integrates advanced sorting, digital traceability, process modelling, recycling, upcycling, and circular design approaches to improve the quality, safety, durability, and uptake of secondary materials in automotive applications. Artificial intelligence, robotics, spectroscopy, digital twins, blockchain-enabled Digital Product Passports, life-cycle assessment tools, and circularity indicators are being developed to support material identification, process optimisation, traceability, and decision-making across the value chain. EcoPlast also addresses advanced material recovery routes, including dissolution recycling for the recovery of high-purity polypropylene and glass fibres from end-of-life composite parts, as well as chemical and enzymatic depolymerisation pathways for selected plastic streams. The developed solutions will be demonstrated using real automotive components, while a digital circular marketplace will support the exchange, qualification, and wider adoption of recycled and upcycled materials across the European automotive sector.

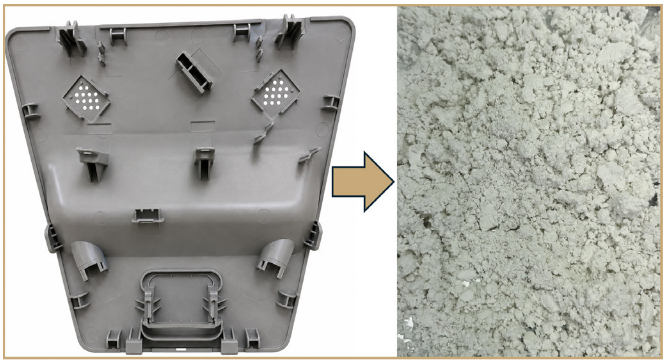


Role of Dissolution Recycling in Ecoplast: Long glass fibre-reinforced polypropylene composites are widely used in automotive applications but remain difficult to recycle mechanically because processing can shorten the fibres and reduce their reinforcing performance. If the glass fibres cannot be effectively separated or preserved, the recycled material may show lower mechanical strength, reduced market value, and limited reuse potential, increasing the risk of downcycling or landfill disposal. Within EcoPlast, Kordsa aims to demonstrate pilot-scale dissolution recycling to recover both high-purity polypropylene and glass fibres from complex composite waste streams while minimizing further fibre breakage. The process will be demonstrated using Kordsa's pilot system to validate process performance and evaluate the reuse potential of recovered materials in automotive applications. In preliminary studies of EcoPlast, a structural automotive component containing 20% glass fiber was recycled, and the glass fiber and polypropylene (PP) fractions were successfully separated from each other. Other additives and fillers present in the PP fraction, such as carbon black, were also removed, resulting in a purified PP sample. The reusability of the recovered glass fiber and PP fractions will be further investigated in the next stages, following the completion of scale-up activities.

TÜBİTAK SAYEM 1833 Platform: Building a Circular Polyolefin Ecosystem in Türkiye

Alongside European initiatives such as EcoPlast, Kordsa coordinates a national circularity platform under the TÜBİTAK SAYEM 1833 Green Transformation Programme, co-funded by TÜBİTAK and the World Bank. The project, entitled "Sustainable Waste Management: Eco-Friendly Recovery of Polyolefin Waste and Integration into High-Value Sectors", aims to establish a circular polyolefin value chain by combining dissolution recycling, digital waste management, material traceability, compounding, and industrial validation.

The platform brings together partners from waste management, digital technologies, polymer recovery, compounding, manufacturing, and end-use sectors, including automotive, packaging, white goods, textiles, and composites. As coordinator, Kordsa leads the industrial implementation of pilot-scale polyolefin recovery and the integration of recovered PP and PE



into application-specific material solutions. The project aims to accelerate the the industrialization of the technology, demonstrating a nationally coordinated pathway from research and pilot validation to commercial deployment and market adoption in Türkiye.

In preliminary studies carried out within the scope of the project, flax fiber and polypropylene (PP) were separated from flax fiber–reinforced PP composite parts, and the quality of the recovered fractions was evaluated. According to TGA analysis, a high-purity PP fraction was obtained. The flax fiber fraction was also recovered with suitable fiber length and quality, making it potentially reusable for yarn production. In another PP-based study, an automotive trim component containing 20% talc was recycled. The filler materials were removed, and TGA results showed that the recovered TPO is an ultra-purified polymer fraction. Further studies and scale-up activities are ongoing within the project using different sample types selected according to sectoral needs.

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Trinseo's Integrated Industrial Recycling Platform

Dissolution recycling is often associated only with solvent-based recovery technologies; however, successful industrial implementation requires much broader capabilities. Consistent production of high-performance recycled engineering plastics depends on control of the entire value chain, from feedstock qualification through polymer purification and development of the final product by application.

Trinseo has developed an integrated platform combining waste management, proprietary recycling technologies, formulation expertise and established commercial channels within a single organization. This integration enables optimization of each stage while ensuring the recycled material satisfies the technical requirements of demanding end-use applications.

Feedstock Qualification and Waste Management

The quality of recycled polymers is fundamentally linked to the quality and consistency of incoming feedstocks. Through Heathland, Trinseo operates waste collection, sorting and pre-treatment activities for both post-consumer (PCR) and post-industrial (PIR) plastic waste streams. This enables characterization and qualification of feedstocks before they enter the recycling process and provides greater control over raw material variability compared with purchasing secondary materials from the open market.

The availability of internal waste management capabilities also facilitates the development of dedicated collection routes.

Figure 3: Trinseo's waste access route: Heathland

Trinseo's Dissolution Recycling

Trinseo has developed a dissolution-based recycling platform for engineering plastics that combines polymer purification with molecular property restoration and formulation know-how. Rather than representing a single unit operation, the platform consists of four integrated process stages that convert complex plastic waste into application-ready recycled polymers (Figure 4).

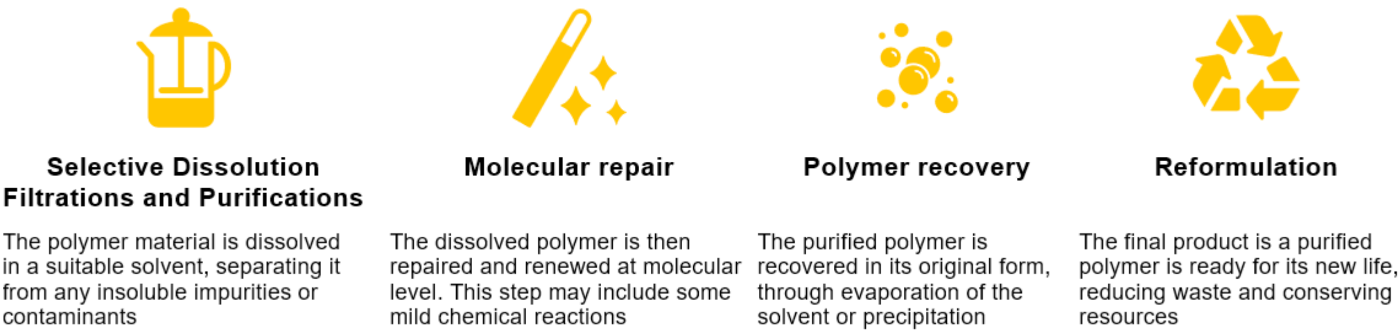

Figure 4: Trinseo's dissolution recycling technology

The process begins with selective dissolution of the target polymer using an appropriate solvent. Insoluble constituents including incompatible polymers, pigments, fillers, metals, glass fibres, elastomers and other contaminants remain outside the solution and are removed through filtration and solid-liquid separations. Additional purification steps can be incorporated where necessary to remove soluble impurities or legacy additives, depending on the target application and feedstock composition.

Following purification, the dissolved polymer can undergo molecular repair to compensate for degradation accumulated during previous processing and service life. Depending on the polymer system, this stage may be used to restore molecular weight, adjust rheological behaviour or improve processing/application performance. The objective is to recover material properties required for demanding applications while contributing to the integrity of polymer backbone.

The purified polymer is subsequently recovered by separating the solvent from the polymer, typically through solvent evaporation and devolatilization. The recovered solvent is recycled within the process, while the polymer is obtained in a form suitable for downstream processing and compounding.

The recovered polymer is finally reformulated into application-specific compounds. Existing formulation expertise allows the recycled polymer to be combined with stabilizers, impact modifiers, flame retardants, reinforcing fillers, pigments or virgin resin where required to meet targeted performance specifications. This final stage enables recycled engineering plastics to satisfy application requirements rather than being treated as generic recycled materials

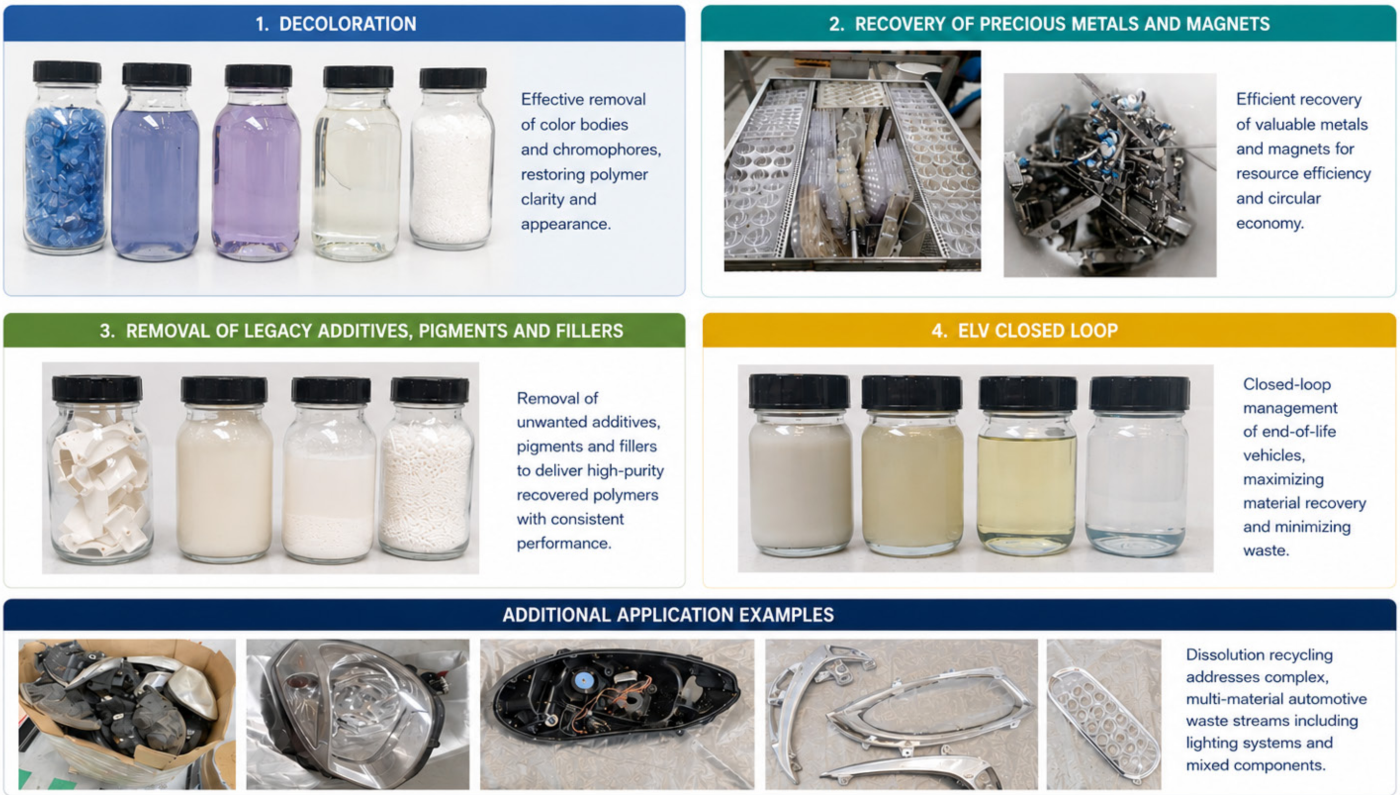

Figure 5: Capabilities of Trinseo's dissolution recycling technology

Polymer-Specific Dissolution Technologies

Engineering plastics differ significantly in chemistry, morphology and application requirements. Consequently, no single recycling technology is optimal for every polymer.

Trinseo has therefore developed complementary recycling technologies, selecting the most appropriate route according to polymer characteristics. Mechanical recycling remains an important solution for suitable waste streams, while depolymerization is applied where recovery of monomers provides the greatest value and can be achieved in high yield. Dissolution recycling complements these technologies by enabling purification of complex engineering plastics while retaining the polymer backbone.

Within dissolution recycling, Trinseo has established polymer-specific platforms covering major engineering thermoplastics.

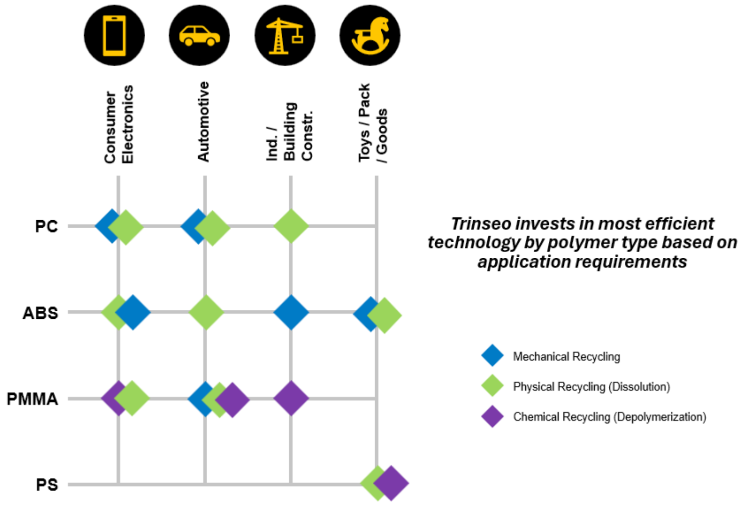

Figure 6: Trinseo recycling technologies per polymer per application space

Polystyrene (PS)

Polystyrene dissolution recycling has been commercial since 2020 and demonstrates industrial implementation of solvent-based recycling. And since 2025, Trinseo's dissolution recycled rPS has been approved for direct food-contact applications, illustrating the ability of dissolution recycling to achieve the purity levels required for highly regulated markets.

Figure 7: Trinseo's dissolution recycled rPS approved for direct food contact applications

Polycarbonate (PC)

Trinseo's polycarbonate platform has progressed to TRL 7 with commercial deployment under preparation. The process enables recovery of high purity recycled polycarbonate from complex waste streams while removing pigments, fillers, incompatible materials and legacy additives. Additional molecular repair and formulation steps allow the recovered polymer to be tailored for demanding engineering applications including automotive, electrical and consumer products.

Figure 8: Trinseo's PC dissolution technology for ELVR compliance

Acrylonitrile-Butadiene-Styrene (ABS)

ABS presents additional challenges because of its multiphase structure consisting of a SAN matrix and rubber particles together with pigments and other additives. Trinseo has developed a proprietary dissolution process that selectively separates and purifies the SAN phase while enabling subsequent reformulation into high-performance recycled ABS compounds. Technology has been demonstrated on a TRL 6 pilot scale and is progressing towards commercial implementation.

Test	Unit	Mechanical Recycling[1]	Dissolution Recycling[2]
Charpy Impact	kJ/m^2	9	32
MFR (220 °C/10 kg)	cm^3/10min	2.2	21
Yield stress	MPa	43	38
ELongation @Y	%	2	2
Rupture Stress	MPa	36	31
Elongation @R	%	11	24
Modulus	MPa	2510	2200

Figure 9: Comparison of properties for recycled ABS from sorted ELV plastics.1) Mechanical recycling: Shreds were extruded without further purifications 2) Trinseo's dissolution recycling involves selective dissolution and purification of SAN which which was then reformulated into ABS

From Recycled Polymer to Engineering Compound

Producing a purified recycled polymer represents only part of the value creation process. Engineering plastics must satisfy stringent mechanical, thermal, rheological and processing requirements that differ between applications.

As a long-established producer of engineering plastics, Trinseo combines dissolution recycling with decades of formulation and compounding expertise. Recovered polymers can therefore be incorporated into application-specific formulations using established additive packages, stabilization strategies and processing know-how, enabling recycled materials to meet customer performance specifications.

Figure 10: Automotive parts produced using Trinseo's recycled resins. Dissolution recycled PC and ABS produced in pilot plants in Terneuzen for trial purposes.

Customer Integration

Industrial deployment ultimately depends on customer qualification and market acceptance. Trinseo's long-standing relationships with OEMs, Tier suppliers, compounders and brand owners provide direct pathways for evaluation, qualification and commercial implementation of recycled engineering plastics across multiple applications.

This integration of feedstock management, recycling technologies, formulation expertise and commercial engagement distinguishes Trinseo's approach from organizations focused solely on recycling technology development. In addition to supplying recycled polymers, the platform is designed to deliver application-ready engineering materials capable of supporting circularity in demanding industries such as automotive, electrical and electronic equipment, consumer goods and construction.

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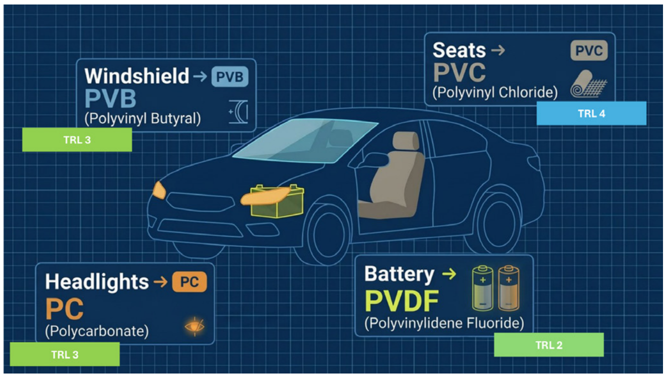
Polyloop ELV Recycling Processes

Polyloop employs a recycling process based on selective dissolution of the target polymer. The solvent blend and operating conditions are adjusted to selectively target PVC, PC, PVB, and/or PVDF.

The precipitation step yields the polymer as a compound, retaining its plasticizers and fillers.

- PVC from wiring harnesses is separated from copper and other plastic components.
- PVC from seat covers is separated from the PES (polyester) backing fabric. PVB from windshield laminated glass is separated from the glass.
- PC is recovered as white pellets — the polymer does not undergo darkening during the process.
- PVDF present in battery electrodes is separated from aluminum and CAM (Cathode Active Materials), enabling their independent recovery through dedicated recycling streams. This PVDF process is still under development.



Company information

Polyloop develops selective dissolution technologies for the recycling of complex plastic waste streams. The company focuses on recovering engineering and specialty polymers from products that are difficult to recycle using conventional mechanical processes.

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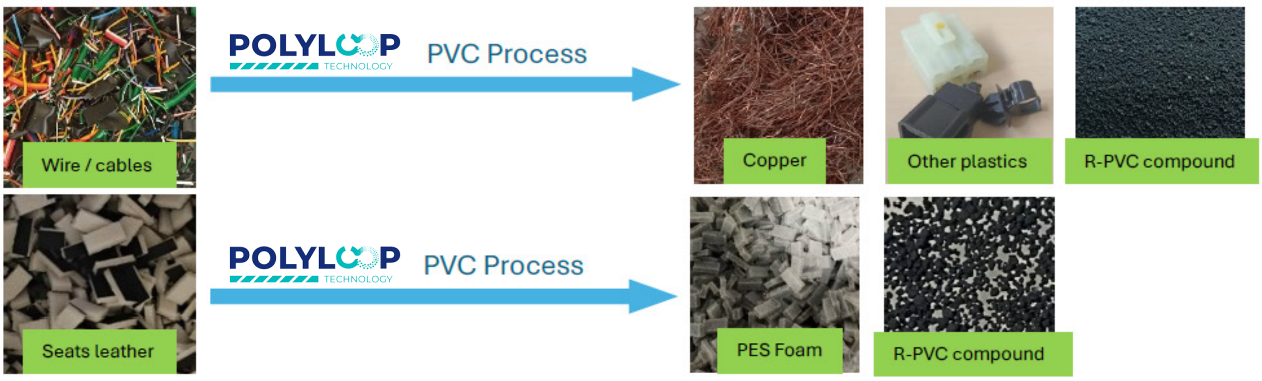
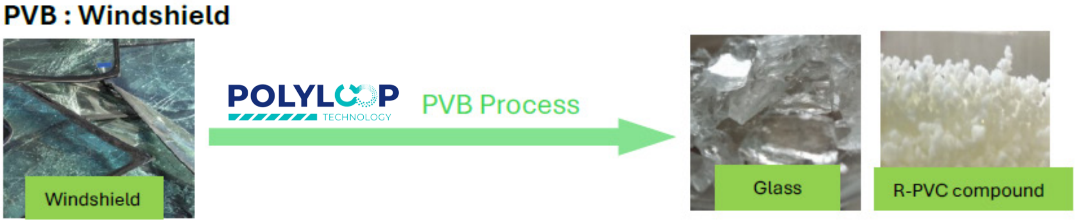
PVC : Seats : artificial leather + foam and wire



PVB : Windshield



PC(+ABS): Headlights, Rigid trim & housing components

Closing the Loop on Automotive Seat Covers

Combined Dissolution and Chemical Recycling of PVC-Coated Fabrics and PU Foam

The Seat-Cover Challenge

Automotive seating is one of the most material-intensive plastic assemblies in a vehicle: seats account for roughly 10–20 kg of polymers per car, spanning polyurethane (PU) foam, PVC, polyamide, ABS and PP (Table 1 of this white paper). Seat covers themselves are engineered multilayer composites: a plasticized PVC skin (vinyl or synthetic leather) is laminated to a polyester (PES) or polycotton backing fabric, in some constructions with a foam interlayer or as supported expanded vinyl (SEV).

The features that make these materials durable and comfortable also make them practically unrecyclable by conventional means. Because the layers cannot be separated mechanically, shredding yields a mixed PVC–textile–foam fraction that fails quality requirements for reuse, and the stream is landfilled or incinerated at a net cost: end-of-life treatment for this class of automotive interior waste is ca. 200 €/t. The waste nevertheless arises continuously and in structurally homogeneous form from two sources, ELV dismantling and manufacturing scrap from seat-cover cutting and lamination.

One Assembly, Two Complementary Recycling Loops

Oligomaster (Hamilton, Canada), working with Polyloop (France), has evaluated a route that treats the seat cover as a system rather than a single material, so that both major polymer fractions are returned to material use:

- Selective dissolution for the PVC fraction. The coated fabric is processed in a closed batch dissolution–precipitation cycle. A solvent blend selectively dissolves the plasticized PVC matrix, whereas the backing textile, foam and other insolubles remain undissolved and are recovered intact by filtration. The polymer is then recovered by directed precipitation as a ready-to-use r-PVC compound that retains its plasticizers and fillers, and the solvents are recovered and reused in a closed loop.
- Chemical recycling for the PU foam fraction. The cleanly separated foam fraction, seat cushioning and foam backings, feeds the molecular recycling process developed by Oligomaster, which converts post-consumer PU foam into high-quality polyols. The process has been demonstrated on post-consumer mattress foam, a stream that alone sends ca. 180,000 t of PU foam to North American landfills each year, and recovers more than 50% of the virgin polyol used in new foam; a deployment-ready system has been developed. Applied to seat assemblies, the same chemistry closes the loop on the cushioning fraction, so that the dissolution loop (PVC) and the chemical loop (PU) together cover the full material cycle of the seat.

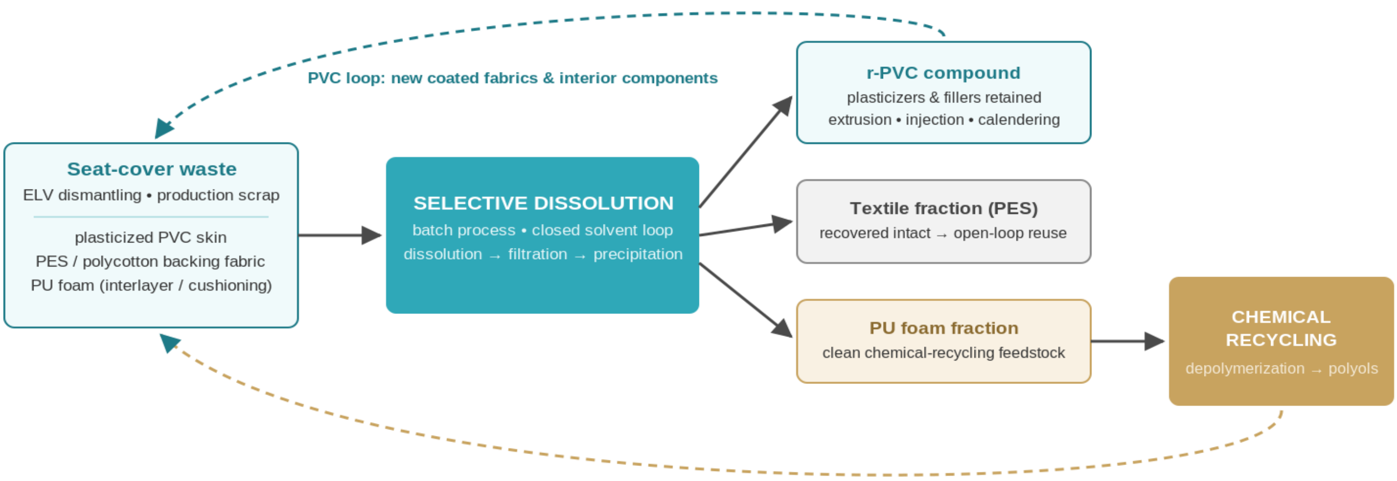


Figure 11: Recycling scheme for the complete seat-cover assembly. Selective dissolution recovers the PVC and separates textile and foam; the foam fraction feeds the chemical-recycling loop.

This case study complements the Polyloop process overview elsewhere in this white paper: it applies the dissolution route to the complete seat-cover assembly (Figure 11) and adds material validation on North American automotive interiors together with an implementation perspective for the North American market.

Validation Evidence

- North American automotive interior materials. Three representative coated-fabric constructions, black and caramel vinyl-skin/polycotton laminates and a tan interior with foam backing and SEV, were processed at laboratory pilot scale in dissolution–precipitation trials. The separation proceeded successfully in all cases, and the recovered r-PVC compound was judged suitable for reprocessing by extrusion, injection molding or calendering, with adjustable particle size (average grain diameters of ~680–780 µm under standard precipitation conditions).
- Seat-cover production scrap (European Tier-1 automotive supplier). Three streams of PVC synthetic-leather manufacturing scrap (PVC ≈ 80 wt%, with non-woven textile, PES fabric and PU foam backings) were recycled at pilot scale. Infrared characterization confirmed recovery of a PVC compound with a formulation close to the input material, while polyester fibers and PU foam were recovered as separate insoluble fractions available for open-loop reuse or, in the case of the foam, for chemical recycling. An indicative assessment, with r-PVC substituting virgin compound at ~1,500 €/t against avoided disposal at ~180 €/t, gave a payback time of ca. six years for a 540 t/y batch unit.
- Resource intensity. Measured utility consumption for a 300 kg reference batch (electricity ~217 kWh, steam ~1 t, solvent make-up ~5 kg) provides a transparent basis for scale-up assessment and life-cycle analysis.
- Recyclate quality control. To support industrial adoption of dissolution recyclates, Oligomaster has established a quality-control methodology for rigid and flexible r-PVC based on FTIR, NMR and GC-MS identification and quantification of contaminants, plasticizers and additives. The work is carried out within an NSERC-supported research network spanning four Canadian universities and feeds into recyclate standards development with the Vinyl Sustainability Council, the Vinyl Institute, ASTM and ISO.

Toward Circular Seating in North America

Because the process operates in compact batch units, capacity can be deployed close to where the waste arises, at dismantlers, seat manufacturers and coated-fabric producers, rather than shipping heterogeneous waste to a distant central plant. Batch operation also preserves traceability of incoming material, which supports the qualification of recyclates for automotive interior use and, in Europe, documentation of closed-loop ELV content under the forthcoming ELVR quotas. For North America, where dedicated ELV plastic recycling infrastructure is largely absent, the seat-cover stream is a pragmatic entry point: it is identifiable at dismantling, compositionally consistent within component families, and currently carries a disposal cost that a recycling route converts into value.

Next steps include feedstock aggregation and specification with dismantling and manufacturing partners, shaping and qualification trials of the recovered r-PVC in interior applications, integration of the PU chemical-recycling loop, and a demonstration pilot with an OEM or Tier-1 partner.

Company Information

Oligomaster Inc. (Hamilton, Ontario, Canada) is an innovation-as-a-service company advancing modular physical (dissolution) recycling and chemical recycling in North America. Its circular-vinyl program combines modular STRAP-based recycling units (>500 t/y per industrial unit), recyclate quality-control methodology, reformulation development, and molecular recycling of PU foam into polyols. The work is supported by a $1M NSERC Mission Alliance grant with research groups at four Canadian universities; Oligomaster is an associate member of the Vinyl Sustainability Council and a member of the DROP-IN initiative.

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DROP-IN

Dissolution Recycling of Plastics Initiative

https://drop-in.network