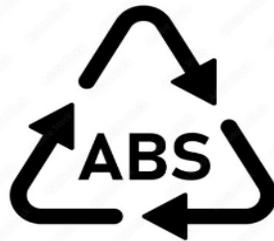


Recycled ABS Plastic & Additional Eco-Friendly Solutions

Education Blog By: Tyler Kanczuzewski, Sustainability Manager

Logistick, Inc.

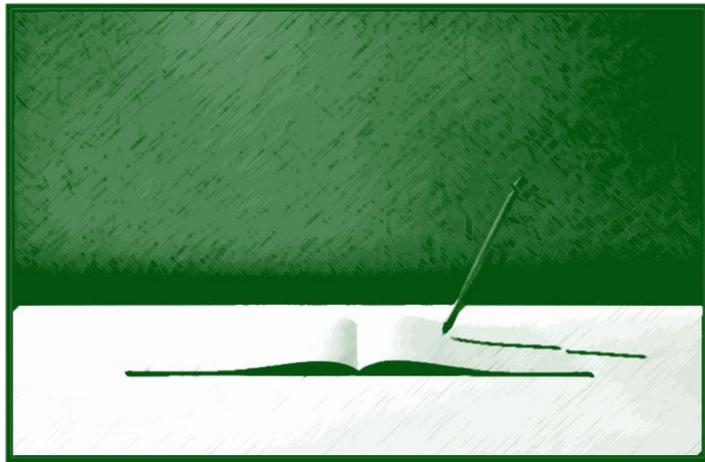
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Executive Summary

This educational blog writeup presents a detailed analysis of Acrylonitrile Butadiene Styrene (ABS) resins, recycled ABS, and alternative eco-friendly solutions. It takes a dive into their environmental footprint and highlights the importance of sustainable alternatives for the future.

Recent trends in the materials industry show movement towards improved sustainability, driven by evolving consumer preferences and more regulatory shifts. Organizations are increasingly dedicating resources to research and development aimed at producing environmentally friendly alternatives that retain the functional advantages of conventional ABS resins while minimizing ecological impact. This evolution is influencing product engineering, supply chain strategies, and life cycle management across multiple sectors.

ABS resins are widely used for their properties, but environmental concerns are driving interest in sustainable alternatives. This writeup covers ABS resin chemistry, performance, uses, and their potential impacts. Alternatives like recycled ABS, and various bioplastic related solutions are reviewed and compared to ABS in terms of key features, benefits, and drawbacks. Technical and economic challenges for eco-friendly materials are discussed, along with opportunities for innovation and reducing environmental impact.

Advancing toward a more sustainable future in ABS materials and eco-friendly alternatives requires ongoing collaboration among business networks, industry leaders, researchers, and policymakers to continue to drive innovation and overcome existing barriers. As organizations evaluate and adopt more eco-friendly alternatives, careful consideration of life cycle impacts, material performance, and regulatory compliance will be essential. The continued development of unique resins and the integration of biomaterial and renewable feedstocks into production processes will be essential in reducing the environmental footprint of plastics such as ABS. By leveraging emerging technologies and prioritizing responsible sourcing, companies can position themselves at the forefront of sustainable manufacturing, ultimately contributing to a more resilient, innovative and environmentally conscious industry.

Introduction and Background

What is ABS plastic resin? Long story short, it is a very innovative material that was created in 1940's by Borg-Warner Corporation. ABS plastic is a brilliant copolymer that is both rigid and resilient and can be used for many different applications ranging from car parts, appliance housings, to pipe fittings. Think tough, diverse, and heat resistant. In many ways, ABS plastic (or plastic in general) is different than wood, metal, and glass. A big part of that conversation is comparing organic vs. synthetic, or regenerative material, but we will get to that later. Now, let's get a little more technical and scientific about ABS plastic and the acronym meaning.

According to the book *Extrusion*:

“Acrylonitrile butadiene styrene (ABS) is an amorphous resin. Its properties depend on the acrylonitrile, butadiene, and styrene monomer ratio and how these components are polymerized and formulated. For good chemical resistance, heat resistance, and long-term thermal stability, the formulation needs to be rich in acrylonitrile content. Formulations high in styrene content have good gloss, excellent moldability, and good strength and rigidity, while butadiene contributes low temperature impact and general property retention. ABS is manufactured two ways:

- *In the first method, copolymers of styrene/acrylonitrile (SAN) are blended with butadiene/acrylonitrile rubber (NBR). Normally the rubber phase is broken up and uniformly dispersed in small particles as the discontinuous phase in the SAN continuous phase.*
- *The second manufacturing approach, used in most operations today, provides more versatility and ability to custom design specific property profiles. Acrylonitrile is grafted (chemically bonded) onto a butadiene or butadiene styrene copolymer backbone.*

Polybutadiene–SAN blends are incompatible. If the two materials are blended, the polybutadiene has to be uniformly dispersed in the SAN continuous phase as very small particles. Even with the proper concentration and polybutadiene distribution, the toughness of the SAN matrix is only marginally improved due to resin incompatibility. However, if the proper styrene-acrylonitrile ratio is grafted onto a polybutadiene backbone, the polymer becomes compatible with the SAN copolymer; the two resin systems can be blended, with the resulting polymer alloy having improved toughness. The properties anticipated for ABS depend on the ratio of the three components in a particular formulation, shown in Table 22.1. As with most polymer resin systems, not all properties are maximized in one formulation; it is always a give and take situation. If the formulation has a high butadiene concentration, the impact is good. High styrene concentrations improve processability, while high acrylonitrile concentrations improve chemical resistance and hardness. Tensile and flexural properties tend to decrease as impact increases. Other monomers can be incorporated in the polymer molecule to improve the performance profile, such as substituting alpha methyl styrene for styrene to raise the heat deflection temperature.

Table 22.1. Property Ranges for ABS

Property	Maximum	Minimum
Specific Gravity	1.07	0.99
Tensile Strength, psi	11,000	2,500
Flexuran Modulus, psi	500,000	100,000
Flexural Strength, psi	15,000	2,000
Izod, ftlbs/in	13.0	0.8
Hardness, Rockwell R	123	
Hardness, Shore D		62
HDT @ 264 psi, °C	110	63

Source: H. Giles, Jr., J. Wagner, Jr., and E. Mount, III, Processing Recommendations for Various Resin Systems, in Extrusion: The Definitive Processing Guide and Handbook, William, Andrew. New York, NY, USA: Elsevier, Inc., 2005, pp. 207-219.

ABS is mildly hygroscopic. The moisture absorbed is directly related to the relative humidity in the surrounding air. Moisture absorbs the pellet surface and migrates into the center. As ABS is not shipped in moisture-proof containers, the pellets must be dried prior to processing. Pellets that have been dried will reabsorb moisture if they are exposed to the atmosphere. Consequently, once pellets are dried, they need to be used or stored in a moisture-proof container for later use. The absorption rate depends on the relative humidity, pellet, or particle size, temperature, time, and the ABS grade. Smaller particles and higher temperatures increase the absorption rate. Higher acrylonitrile grades absorb more.” [1]

ABS plastic is considered by many to be one of the best engineered plastics, especially because it can be substituted for metal. It can be manufactured or formed by utilizing four major methods – injection molding, thermoforming, 3D printing, and CNC machining. ABS is well engineered and used in a wide range of applications commercially and industrially, but it does have environmental implications. That brings us to the next question, what are the **environmental impacts of ABS resins**, and similar plastics?

We now live in a world of plastics. We hear about microplastics appearing in our food and water, and that the average person may consume a credit card amount of plastic weekly. For better or for worse, plastic is here, and it’s not going away anytime soon. Most plastic does not get properly disposed of along with other types of waste streams, and ends up in waterways or on land somewhere, and that is another problem. The issue with plastic is that it is typically synthetic and non-renewable, meaning using fossil fuel resources and chemical processes to make the plastic. When humans create things in a lab using chemicals and petroleum, that creation is typically not naturally occurring or renewable on earth, therefore it can be harmful if not properly disposed of. The good thing is that most plastics are recyclable or reusable if the proper infrastructure is in place to collect the used materials, or waste. ABS plastic is classified as a number 7 “other” plastic for recycling infrastructures. Anything made of mostly ABS plastic should have a number 7 recycling

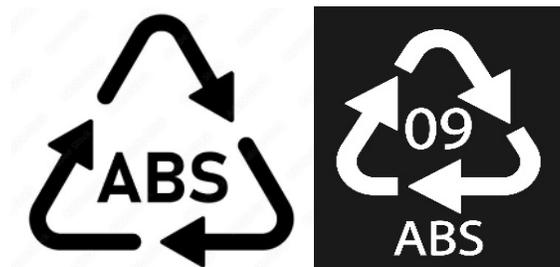
emblem listed on the product itself, and in some cases, it may just say “ABS” with recycling emblem or a number 9 in even rarer cases. See graphics on the next page.

Plastic by Type and Recycling Emblem Number:

1	2	3	4	5	6	7
PETE	HDPE	PVC	LDPE	PP	PS	OTHER
polyethylene terephthalate	high-density polyethylene	polyvinyl chloride	low-density polyethylene	polypropylene	polystyrene	other plastics
soft drink bottles, mineral water, fruit juice container, cooking oil	milk jugs, cleaning agents, laundry detergents, bleaching agents, shampoo bottles, washing and shower soaps	trays for sweets, fruit, plastic packing (bubble foil) and food foils to wrap the foodstuff	crushed bottles, shopping bags, highly-resistant sacks and most of the wrappings	furniture, consumers, luggage, toys as well as bumpers, lining and external borders of the cars	toys, hard packing, refrigerator trays, cosmetic bags, costume jewellery, CD cases, vending cups	including acrylic, polycarbonate, polyactic fibers, nylon, fiberglass

Source: Plastic Pollution Coalition

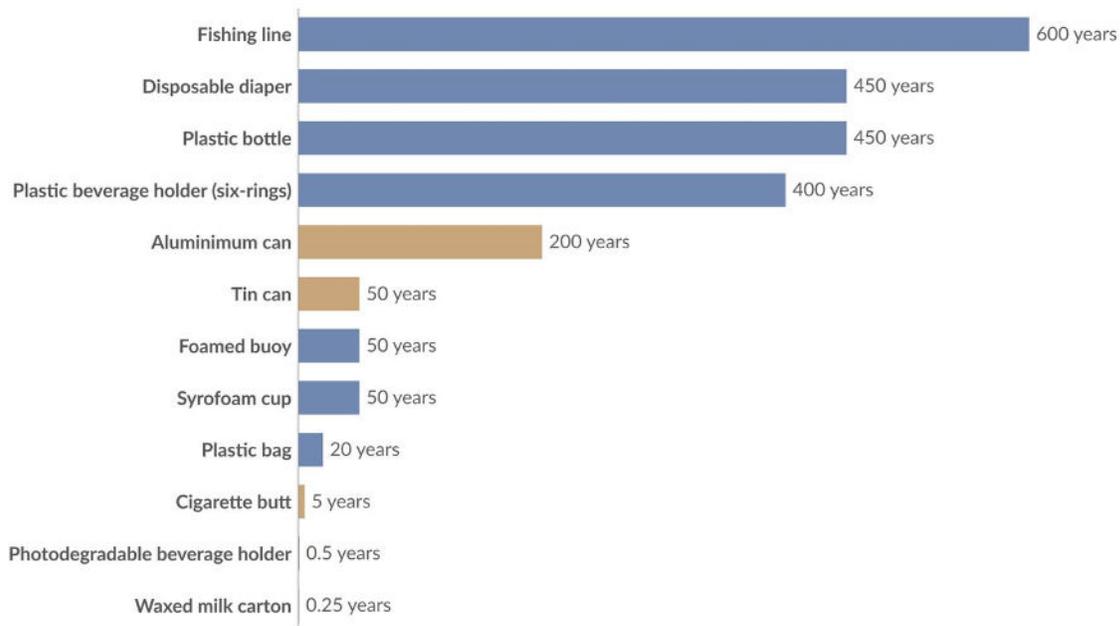
The problem is that a lot of plastic is not properly recycled or even landfilled. Whether plastic is floating in the ocean or sitting in a landfill, it can take hundreds of years to decompose. Some ABS plastics may take 500-1,000 years to decompose. ABS is very innovative, strong and resilient, but sitting in a landfill or body of water for that long may not be the best long-term solution. Alternate options must be considered, and luckily they are. We will discuss potential solutions and ongoing efforts. Innovation is what created plastics, and it will take continued innovation to make them more sustainable for the planet long-term.



Decomposition rates of marine debris



Average estimated decomposition times of typical marine debris items. Plastic items are shown in blue.



Data source: U.S. National Park Service; Mote Marine Lab; National Oceanic and Atmospheric Administration Marine Debris Program
OurWorldinData.org/faq-on-plastics | CC BY

Now for the good news. There has been a growing movement toward finding alternative plastics or solutions that are more eco-friendly, easier to recycle or reuse, or are even compostable. But are they comparable to the strength and resilience of ABS plastic?

First off, what is the importance of finding eco-friendly alternatives? It really is a straightforward answer: to use materials or feedstock that are better for the environment and the entire planet. Not only to avoid harmful microplastics that humans and animals are potentially consuming, but to also avoid the negative environmental footprint from a life cycle perspective. Many products or materials can be researched using life cycle assessment methodology (LCA).

- Resource Extraction or Mining, into Material Processing
- Manufacturing and Energy, into Distribution and Logistics
- Using the Product or Materials, into End-of-Life Management

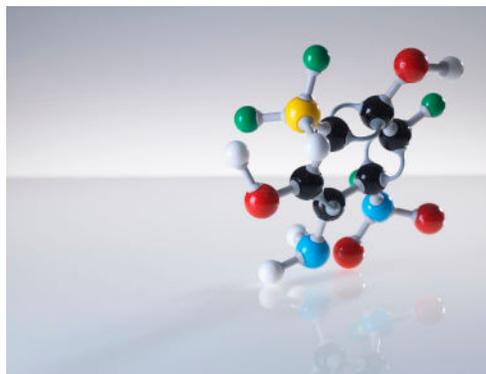
Traditionally, products and materials are dealt with using a linear framework of take, make and waste model, but now circular methods are being heavily adopted across many industries to lower environmental footprint and adopt more regenerative and circular thinking. Eco-friendly plastics or alternatives can be analyzed by LCA or circular methods too.

The Landscape of ABS Resin

The chemical makeup of ABS resin is unique, innovative, and high performing. According to British Plastics Federation, ABS is the optimal material for colorfastness and superlative surface quality, rigidity, hardness and heat resistance. The toughness of ABS is the result of sub-microscopically fine polybutadiene rubber particles uniformly distributed in the SAN (styrene-acrylonitrile copolymer) matrix. ABS is also cost-effective and generally lightweight for how innovative and superior it is. [2]

Critical Qualities and Attributes of ABS Plastic:

- ✓ Readily Modifiable (additives and ratio of monomers Acrylonitrile, Butadiene, and Styrene)
- ✓ High quality surface finish, like matte, glossy, or satin
- ✓ High and Medium Impact, and high heat resistance or fire retardancy
- ✓ Fiber reinforcement capability to increase stiffness and dimensional stability
- ✓ Readily blended or alloyed with other polymers to increase range of properties, as well as electroplatable (with thin layer of metal)
- ✓ Can be made transparent or colored
- ✓ Variety of grades available for different applications
- ✓ Injection molded or extruded [3]



There are a wide range of applications and industries using ABS resins like automotive, electrical, and office equipment. Examples include - automotive interior and exterior trim components, lawn mower covers, safety helmets, luggage shells, equipment housings, pipes and fittings. When you consider the range of applications, it is truly impressive and efficient. Not many materials have that same capability, making ABS very desirable across many industries, and for diverse uses. ABS can also be recycled and repurposed repeatedly into new feedstock with some fresh additives and minor reprocessing, which is another strong selling point economically and environmentally.

Environmental Concerns and Regulatory Pressures,

One could argue that if it was not for plastic, things like sending people and spacecraft to the moon would have been impossible. For example, spacesuits utilize many types of plastic and synthetic polymers.[4] In fact, NASA and the space exploration program led to the invention of many materials and technologies that are used today. But all great innovations can also have their drawbacks. And to that point, there are some environmental concerns and regulatory pressures around plastic materials that must be discussed.

Plastic getting into drainage systems, drinking water, rivers, lakes, and oceans is a concern. The root cause of this is poor recycling and waste management infrastructures, and littering/pollution. When plastic is left unmanaged in the natural world, it slowly breaks down into microplastics (MP) that can get into the food and drinking water of animals and humans. Businesses and organizations working with plastic have been somewhat proactive around this issue, an example is through [Operation Clean Sweep \(OCS\)](#), an industry-led program to eliminate loss of plastic resin in operations to preserve water quality, protect the environment, and worker safety.

Decomposition time, and contribution to global methane emissions is also a concern. In general, it takes a very long time for plastic materials to degrade. It takes 500 years plus for some materials to decompose, and even then, you still have microplastics to deal with.[5] Plastic contributes to methane emissions whether floating around the planet or trapped in a landfill. Unfortunately, human induced methane emissions are bad in terms of the greenhouse gas effect (GHG), trapping heat and helping warm the atmosphere quicker than natural planetary ways.[6] The solution is more recycling, a lot more, and more efficiently!

The energy required to make plastic materials and the limited resources that are available to make them, or scarcity, are also serious considerations. According to the EPA (United States Environmental Protection Agency) and The Organization of Economic Development and Cooperation (OECD), in 2019, 3.4% of greenhouse gas emissions were created from plastic products, and 90% of these emissions came from the production and conversion of fossil fuels into new plastic products. They also predict that with human development trends, emissions will go up over time unless human behavior alters, and greenhouse gas emissions associated with the life cycle of plastic products are expected to double by 2060. Even The World Economic Forum projects that without strategic intervention, the global plastics industry will account for over 20% of total oil consumption and up to 15% of global carbon emissions (CO₂) by 2050.[7] Fossil fuels have reserves and are finite, which is a major concern. Fossil fuels are not regenerative (renewable) as far as we know, so it makes sense to become infinitely more efficient with general plastic recycling and reuse, and in parallel, adopting and inventing more eco-friendly plastics and plastic alternatives.

On a positive note, ABS can be recycled and repurposed repeatedly into new feedstock with fresh additives and minor reprocessing, which can lower its environmental footprint. Many products are made entirely from repurposed ABS, which has been a growing movement.

Defining and Evaluating Eco-Friendly Materials

According to the Merriam-Webster Dictionary, the definition of eco-friendly is - not harmful to the environment, or environmentally friendly.[8] Eco is derived from ecology, and ecology is the study of the natural world and organisms, and how they interact together in different or unique environments.[9] When you boil it all down, the environment is delicate, and it is important for human development to minimize negative impacts to the natural world. That is why the world of commerce and material management is trending heavily towards eco-friendliness. The good news for the plastic industry, both producers and consumers, is that there are positive solutions.

To examine and evaluate what might be more eco-friendly, you can consider factors like recyclability, renewability, decomposition, life cycle, and carbon footprint. Often, there can be a cost premium to eco-friendly solutions and alternatives because the volume demand is not big enough yet (economics 101). Additionally, there might be a lack of quality or structural integrity when compared to its less eco-friendly counterpart. The biggest talk in the world of eco-friendly plastic is biodegradable. Biodegradable or compostable material breaks down much faster and is usually made up of more organic material or is mostly plant-based. The popular catchword for this is bioplastic, or bio-based plastic. Bioplastics are typically made from regenerative or renewable feedstocks that are more readily available, or able to be harvested and regrown (biomass like algae, bacteria, crops, or plants), as opposed to non-renewable and finite resources like synthetic oil-based plastics. The issues or hurdles for bioplastics are scale, land-use, and recycling/composting infrastructure. Let's start with recycling and composting. According to the EPA, on average plastic makes up around 13% of landfilled municipal solid waste (MSW), and we only recycle 9% of total plastic waste generated. So, we are inefficient at recycling plastic.

As for composting, it is growing momentum at a grassroots level, but not as fast from an industrial standpoint. Big scale composting and technology like anaerobic digestion can also be costly. To compost bioplastic, you must have the right regional organizations or infrastructure in place to properly handle the materials. For recycling or recovery, it is important that sorting and separating becomes much more efficient, specifically for bioplastics to get to the right processing facility. For scale, bioplastics make up about 1% of the total plastic market share, with room for massive growth, but feedstock may be more expensive or less readily available. For land-use concerns, the fear is that bio-based plastics will consume or rely on too much cropland, like corn. However, studies suggest that even if bioplastic was to completely replace conventional plastic, only 1.5% of total agricultural land would be needed for growing renewable feedstock. [10]

Life Cycle of Bioplastics and Biomass Waste,

It is not necessarily cut and dry when comparing the environmental footprint of bioplastics vs. traditional plastics. A life cycle analysis is about dissecting the total footprint of a product, from mining or sourcing raw materials, production to disposal, and end-of-life management. Major considerations when thinking about the footprint and the overall impact of bioplastics are:

- Energy, Water and Land Use (**Resource Demand**)
- Sustainable Farming Methods (**Chemical Use, Pollution and other Emissions**)
- Circularity and Material Management (**Elimination of Waste**)

Some bioplastics may consume too many resources, use harmful chemicals or pesticides during the crop growing phase, and create new waste streams. So, it is not as simple as any bioplastic material is better or more eco-friendly than traditional fossil fuel-based plastics. It really depends on holistic practices or company ethics. For instance - using a biomaterial that consumes less resources, especially when converting it into usable feedstock, or, when a facility that uses solar energy and practices closed-loop methods to greatly reduce its waste. It takes a strategic and dedicated focus to create bioplastic or biomaterial that is truly better for the planet and has a smaller footprint compared to traditional synthetic plastics.

Reinventing biomass waste could provide a feedstock option or solution as well. You can use biomass waste from crops, plants, bacteria or algae that is going to be wasted, composted or decomposed somewhere like a landfill. Some organizations are practicing and proving these methods now. A lot of organic or renewable waste is generated and not repurposed properly, so why not use and convert that waste first, then produce or source new material secondarily?

Another consideration is to note the difference between biobased and biodegradable plastic. Biobased means that the material is mostly derived from renewable biological resources such as corn, starch, sugarcane or vegetable oils. Whereas biodegradable reflects a plastics capability to decompose into natural elements like water, carbon dioxide and biomass under the right environmental conditions, and usually with the help of microorganisms. [11]



Alternative Solutions

There are a good number of eco-friendly ABS alternatives available for testing or volume purchases right now. In no order of importance, let us break down some of the known alternative solutions:

- [Recycled ABS Plastic](#)
- [Bio-Additive ABS, Renewable Feedstock](#)
- [Polyhydroxyalkanoates \(PHAs\), Biopolymer & Microbial Polyester](#)
- [Polylactic Acid \(PLA\), Bioplastic](#)
- [Lignin-Based Plastic](#)
- [Custom Materials](#)

Recycled ABS Plastic is a starting point, and really the low hanging fruit for reducing footprint. ABS can be recycled and repurposed repeatedly into new feedstock with fresh additives and minimal reprocessing, which can lower its environmental footprint. Many products are made entirely from repurposed ABS, for instance, Logistick Inc. uses 75% post-industrial recycled ABS resin, with 25% virgin. Recycled ABS can cut environmental footprint by 50%, and lower costs by up to 30%, in addition to minimal strength loss. Recycled ABS solutions should be explored first as the foundation for becoming more eco-friendly. [12]

Bio-Additive ABS is a sustainable solution or alternative to traditional ABS, made with mostly renewable feedstock and designed for circularity. The company Trinseo has various solutions that have a much smaller carbon footprint, compared to traditional ABS options. Trinseo utilizes biomaterial and renewable content (or bio-waste) to make up to 95% of certain material lines, for instance - MAGNUM™ CO₂NET™ BIO ABS. Trinseo claims that this line, and similar lines, can be used with existing equipment and tooling under the same processing conditions. They can provide a verification letter and claim that there is no need to requalify any of the materials, as they are structurally and functionally the same as their fossil-based counterparts. [13]

Polyhydroxyalkanoates (PHAs) is a biopolymer and in the family of microbial polyesters. They form a large group of thermoplastic polymers produced by various prokaryotic organisms and are formed as carbon and energy storage materials under unbalanced nutrition conditions. PHAs production begins with microorganism selection (or fungi and archaea) and fermentation and ends with polymer processing for special purposes. PHAs can be recycled, incinerated, composted, and can also be completely biodegraded and converted into nutrients for living organisms. PHAs are both eco-friendly and versatile but potentially lack strength when compared to traditional ABS materials. Some examples include – packaging, films, and disposable items like hygiene products. [14]

Polylactic Acid (PLA) is a starched based bioplastic using plants, and a sustainable process. PLA is made from lactic acid molecules, and the lactic acid is fermented from plant matter under controlled conditions. PLA is dynamic in terms of use, processing and being very eco-friendly. But there are serious limitations.

According to Xometry:

“PLA is an opaque plastic suitable for making medical components as well as for prototyping applications. PLA is a high strength but brittle plastic that cannot be used in applications that experience shock loads. The lactic acid building blocks of PLA can be made from fermented plant starch, like corn, under controlled conditions. It takes less energy to produce PLA than petroleum-based thermoplastics, making it relatively eco-friendly. PLA is often regarded as being biodegradable, however, it must be noted that PLA does not degrade naturally in the environment and must be composted under a special set of conditions such as a temperature of at least 60 °C, and humidity of 90 % which must be maintained over a period of 60 to 90 days. PLA decomposes into carbon dioxide, lactic acid, and water. [15]

Lignin-Based Plastic is another solution. Lignin is an organic polymer deposited in the cell walls of plants, making them woody and rigid. Lignin Industries AB makes a product called Renol® that is made from a by-product of the forest industry, lignin and biobased oils. The benefit of Renol® is that it can be blended with virgin or recycled ABS to match needed specs. It is versatile and suitable for extrusion or injection molding and can integrate into existing systems. Renol® Recycled ABS 70/30 is a masterbatch designed to be net-negative for CO₂ emissions and is an eco-friendly ABS alternative. This material line is compatible with standard additives and impact modifiers and is a great market fit for many industries. Its natural color is brown like trees, but it can be colored except for white and transparent colors. [16]

Custom Materials, like Sulapac Luxe Flex, are becoming more popular and available as well. The Sulapac Luxe Flex line is a sustainable biobased material, biodegradable biopolymers making up most of the content, and is certified biobased content by USDA. This line can be used for injection molding and can replace hard ABS plastics. The material is resilient to changing temperatures and fluctuations, has high density, good processability, and can be made to have a premium look. Sulapac masterbatches are available in black, as well as other variations. Sulapac is a sustainable solution for existing injection molding systems, however, it seems to be more geared towards the cosmetic industry to make caps, jars, and pencils, and likely comes at a price premium. [17]

Performance Comparisons

Traditional ABS solutions, as well as recycled ABS, are notably strong and versatile in terms of performance, so when comparing any current or new eco-friendly solutions, it can be difficult. Depending on the application, needs can greatly vary. To get a baseline for desired ABS specification ranges, it makes sense to revisit Table 22.1 from our source earlier:

Table 22.1. Property Ranges for ABS

Property	Maximum	Minimum
Specific Gravity	1.07	0.99
Tensile Strength, psi	11,000	2,500
Flexural Modulus, psi	500,000	100,000
Flexural Strength, psi	15,000	2,000
Izod, ftlbs/in	13.0	0.8
Hardness, Rockwell R	123	
Hardness, Shore D		62
HDT @ 264 psi, °C	110	63

Source: H. Giles, Jr., J. Wagner, Jr., and E. Mount, III, Processing Recommendations for Various Resin Systems, in *Extrusion: The Definitive Processing Guide and Handbook*, William, Andrew. New York, NY, USA: Elsevier, Inc., 2005, pp. 207-219.

Depending on exact needs or requirements, there are variations and wide ranges to ABS materials. For some manufacturers, Izod and tensile strength may be critical, and for others melting point, flexibility, or hardness might be more important. Another big variable is the type or method of manufacturing, such as - injection molding, thermoforming, 3D printing, and CNC machining. The type of material required will greatly vary depending on manufacturing method and performance needs, and application type. From an overall performance and environmental perspective, these material solutions may show the most promise and are worth testing and further R&D exploration:

- Lignin Industries AB - Renol® Recycled ABS 70/30
- Trinseo - MAGNUM™ CO₂NET™ BIO ABS
- Sulapac – SULAPAC LUXE FLEX-IM1024.0NC

Individuals can reach out directly to each of these organizations to retrieve spec sheets, pricing and availability, and most importantly, sample the materials to make sure they meet requirements. Most research and development teams should be consulted or even lead the testing of any new material. Each of these material manufacturers may also offer custom solutions to meet more precise specifications. Reach out directly to the manufacturer for general inquiries. Additional solutions may become available in the marketplace as well, so make sure to do your own research as the market evolves.

Case Studies

ABS recycled content has been around for a while, especially in the automotive industry in the form of post-industrial recycled content (PIR). Post-industrial content generally comes from manufacturing waste, like scraps or defective products, and can be easily reprocessed with additives to create fresh resin. ABS can be recycled with additives repeatedly, and that is why companies like Logistick, Inc. are trying to close the loop and recover material for both environmental and economic reasons. Logistick created a [national recycling network](#) for proprietary products containing ABS, in order to create more awareness and grow momentum for closed-loop with partners and customers. Also, when material is handled by consumers it technically becomes post-consumer recycled (PCR) content. PCR content is more commonly collected as municipal solid waste (MSW), like curbside recycling of bottles and cans. Some ABS lines are testing the addition of more PCR specific content to their material mix, and comparing performance and environmental outcomes, which have been generally positive.

Lignin-based material serving as a solution, or filler, to virgin ABS is a relatively new innovation. The formal word for filler in the plastic industry is masterbatch. When using a masterbatch, a carrier resin (base material) serves as the foundation for desired outcomes. For instance, the preferred Izod rating all depends on what percentage of masterbatch you blend with your existing material. According to Lignin Industries AB, using Renol® within existing ABS polymers tends to lock in any specifications. Which also applies to the tensile strength. The material is not used as 100% stand-alone material. Therefore, it is important to understand the intended applications so they can help support you with clearer data points and desired outcomes. One research project replaced 44% of virgin plastic content with bio-based filler and achieved a 40% reduction in carbon footprint. Their standard masterbatch recipe is 50-70% Renol® (which is 90-95% lignin/bio-oil combined with 5-10% natural oil), blended with 30-50% of a target polymer like standard ABS. [18]

Bio-additive ABS includes more renewable feedstock, biomaterial, and bio-waste options compared to lignin-based material. Trinseo launched their sustainable ABS solution in 2022 in conjunction with their 60-80% bio-attributed content. Their bio-ABS solution combines fossil-based feedstock with renewable feedstock in a mass balance process, as they have similar physical properties. They offer three main lines – BIO 60, 80, and 95, and claim to have a product carbon footprint (PCF) reduction of 58, 77 and 92% respectively. The Trinseo MAGNUM™ CO₂NET™ BIO ABS can serve as a drop-in replacement along with a carrier resin to limit virgin material.[19] It was hard to find any case studies, but the information and data available claims that the material, in addition to lower carbon footprint, performs well in thermal and color stability, gloss retention, and dry time.

Custom material solutions offered by Sulapac are now in production and worth exploring. In particular, the Sulapac Luxe Flex line is biodegradable and made of responsibly sourced biobased biopolymers with sustainable fillers. So far, it has gained popularity in the luxury cosmetic packaging industry, and Chanel was one of the first investors. According to the

founders, Sulapac does not own any production facilities, instead they partner with existing production plants allowing for localized manufacturing. Other brands like Shiseido, Lumene, Manik, Schwan and Toly have all launched products or packaging solutions using Sulapac Luxe or Luxe Flex materials. They all claim that having a more sustainable solution, while not sacrificing performance and quality, is a big win. The Sulapac business model is about partnerships and being the eco-friendly go-to option. They have pride in having similar properties to ABS, while proving better end-of-life management. [20]



Challenges and Opportunities

For every problem there is a solution, it is a great motto. But you could also say for every solution there are both opportunities and challenges. When it comes to eco-friendly ABS solutions, there are in fact both challenges and opportunities that must be observed. We can break them down through three pivotal areas – economics, technology and innovation, and environmental impacts.

Economics - Availability and barriers of acquiring are more of a challenge for most of the materials discussed in this writeup. That is because of distribution networks, shipping locations, and volume requirements. Think about the fundamentals of supply and demand. Since most of these eco-friendly material solutions are newer, they will be gradually ramping up production to meet demands, but it may be a slower process. And because some of these products are newer and less available, they will likely be priced higher than traditional ABS lines. As volume demands grow and production ramps up, pricing and availability will drastically improve, leading to more opportunities. There is one clear exception to pricing being a challenge, and that is with recycled ABS plastic. Post-industrial recycled ABS content can cost over 30% less than virgin content, as well as lower the environmental footprint by 50%. Lastly, as policy and regulations are adopted to promote eco-friendly materials, it could totally change the landscape of ABS plastic. Regulations could penalize traditional ABS resins, thus making them cost more. And grants or subsidies could be awarded to eco-friendly alternatives, allowing them to better compete with traditional resins.

Technology and Innovation - From a new development and job creation standpoint, eco-friendly solutions are a big opportunity. Whether it is growing an existing organization, or creating new businesses, the potential for innovation is great. Additionally, as organizations diversify, it can create new revenue streams, grow brand awareness and market value. From a performance, quality, and technical perspective, there is more to debate. It really depends on the material selection and functionality. Traditional ABS is unique, so it raises the bar and makes it challenging for eco-friendly alternatives to contend. However, the research done in this writeup proves that general solutions are available today, have gained momentum and should continue to do so. Even if supply does not improve and costs trend downward, will companies pay a little more for eco-friendly solutions, or sacrifice small amounts of quality or performance for the betterment of the planet? Trends show that organizations are willing to shift, especially with political and consumer encouragement. The industry is evolving.

Environmental Impacts – The eco-friendly solutions discussed in this writeup prove to be impactful, reduce carbon emissions, and reduce waste or the potential for harmful pollution. Less landfilling, or more eco-friendly alternatives being landfilled will reduce methane and carbon emissions. Why not use a material that performs, is competitively priced, and is better for the planet? Organizations should be actively trying to improve every day from a life cycle standpoint, diversification of materials or products, and by providing resilient applications. As things progress, the environmental impacts should improve in parallel. From a ranking perspective, environmental impact is the leader and is the most notable out of these three pivotal areas discussed. It is also our duty to protect the planet, our only home.

Final Takeaways

Advancing toward a more sustainable future in ABS materials and eco-friendly resin alternatives requires ongoing collaboration among business networks, industry leaders, researchers, and policymakers to continue to drive innovation and overcome existing barriers. Organizations must continue to evolve and expand with the market, and encourage others to join the movement, and deepen that collaboration up and down the supply chain. Becoming masters in material management could be a great goal for individuals and groups to navigate sustainability, innovate and make sound economic decisions.

We must also observe that there are innovative and alternative methods to plastic recycling taking place today, for instance incineration to create electricity or recycled “clean” fuel. These can be great back-up solutions when there are hurdles like big volume needs and large floor space requirements to collect materials for basic plastic recycling. Sending these materials to an incineration plant instead could ease those logistical issues. However, incineration is not perfect as there is new energy required and emissions, but it is still better than landfilling. Additionally, the labor needs and cost of workforce to handle collection, storage and the shipping of recycled plastic materials is not always simple. There are costs to shipping, regrinding and reprocessing plastic materials that must always be considered.

As organizations evaluate and adopt more advanced solutions and eco-friendly alternatives, careful consideration of life cycle impacts, material quality and performance, and regulatory compliance will be essential. The continued development of unique resins and the integration of biomaterial and renewable feedstocks into production processes will be essential in reducing the environmental footprint of plastics such as ABS. By leveraging emerging technologies and prioritizing responsible sourcing, companies can position themselves at the forefront of more sustainable manufacturing, ultimately contributing to a more resilient, innovative and environmentally conscious industry. Being more eco-friendly is a lifestyle choice, and it takes everyone working together to make a real difference in our big world. If we treat the planet like it is our only home, it will last longer. The planet is resilient and can heal, but only if we allow it and cultivate that healing path. Lastly, if more companies think more about stewardship and sustainability of their own business, it almost always is better for their community and the planet too.

Be a part of the solution, not the problem.

Reach out to Team Logistick for any follow-up thoughts, questions or concerns. Thanks for reading this white paper and educational blog.

Sustainability@logistick.com

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