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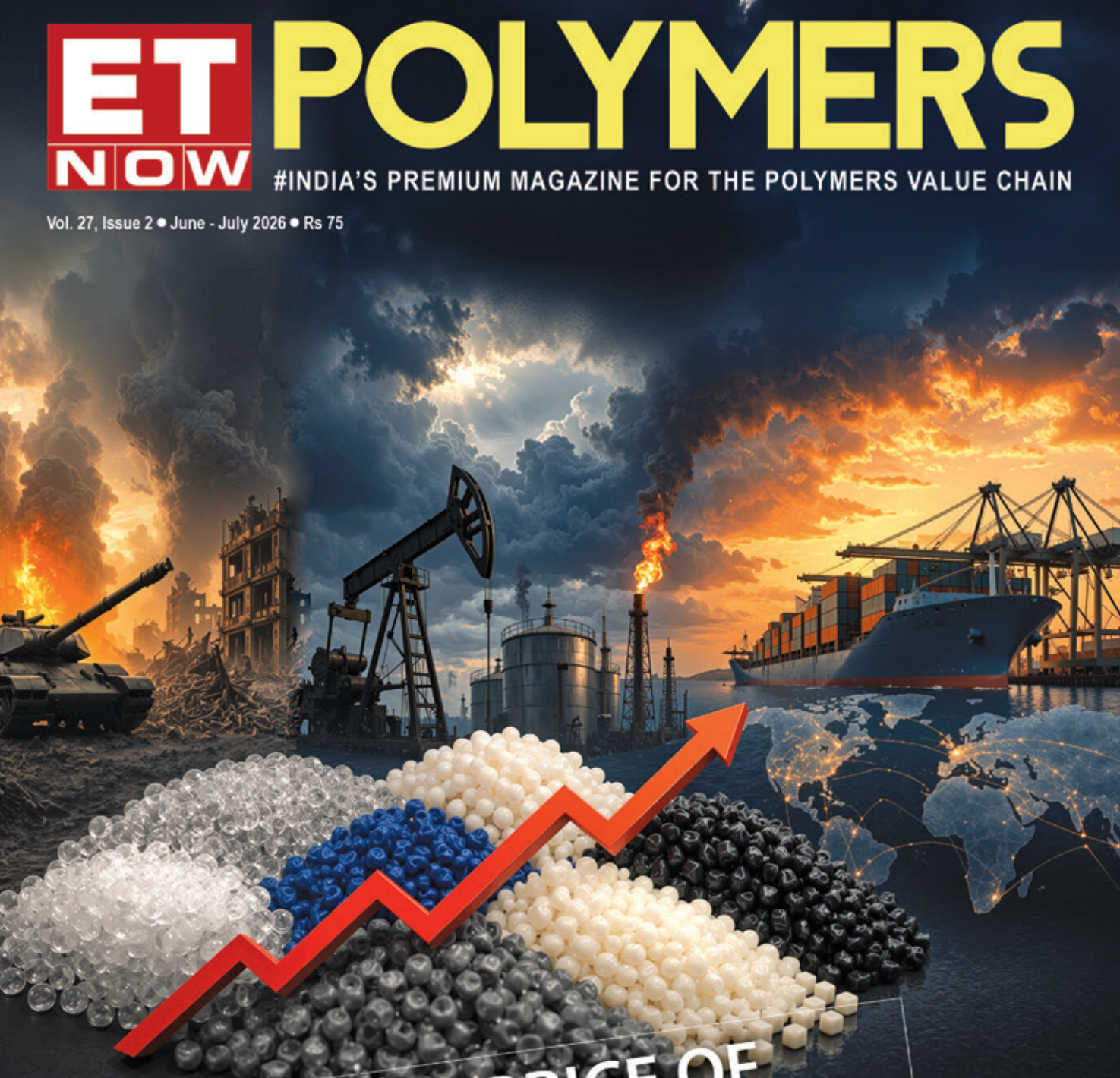

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EDITOR'S NOTE

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Volume 27 Issue 2 June - July 2026

FINDING OPPORTUNITY IN UNCERTAIN TIMES

If there is one word that has defined 2025 and the first half of 2026, it is uncertainty.

Every few weeks, there seems to be a new development somewhere in the world that has the potential to impact businesses, supply chains and markets. From geopolitical tensions and shifting trade equations to fluctuations in energy prices and freight costs, the global operating environment has become increasingly difficult to predict. For the polymers industry, which is deeply connected to global trade and petrochemical value chains, these developments are impossible to ignore.

Our cover story, *The Price of Uncertainty,* explores how businesses are responding to this reality. While volatility is not new, the frequency and scale of disruptions have certainly increased. Planning has become more complex. Cost pressures can emerge unexpectedly. Long term decisions often must be made against a backdrop of limited visibility. Yet, despite these challenges, the industry continues to move forward.

What is perhaps most remarkable is that even as global uncertainty dominates conversations, growth opportunities continue to emerge.

Take packaging, for instance.

As highlighted in our special feature, India's packaging sector is evolving at a pace few would have imagined a decade ago. Driven by changing consumer habits, ecommerce, quick commerce and growing demand for convenience, packaging is no longer just about protecting a product. It has become an important part of the consumer experience and a key driver of innovation across the polymers value chain.

The numbers tell their own story. India's packaging industry is expected to witness strong growth over the coming years, creating opportunities for material manufacturers, converters, recyclers and technology providers alike. What is particularly encouraging is that sustainability is increasingly becoming part of this growth story. Companies are investing in recyclable solutions, reducing material footprints and exploring new approaches that balance performance with environmental responsibility.

Innovation is also gathering momentum across the industry. From smart materials and self-healing polymers to digital product passports and advanced recycling technologies, ideas that once seemed futuristic are steadily finding commercial relevance. Research institutions, startups and established companies are all contributing to this transformation.

There is another reason for cautious optimism. India continues to benefit from a strong domestic consumption story. Demand from sectors such as packaging, healthcare, infrastructure, automotive and consumer goods remain robust, providing a solid foundation even when global markets become unpredictable.

None of this suggests that the challenges have disappeared. Far from it. The months ahead will continue to test the industry's ability to adapt and respond. But if recent years have shown us anything, it is that resilience is no longer a choice. It is a necessity.

And perhaps that is the real story.

Beyond the headlines, beyond the uncertainty and beyond the daily market fluctuations, an industry is quietly reinventing itself. The companies that embrace change, invest in innovation and remain focused on the long term will not simply weather uncertainty. They will help define the future of polymers.

Photography: Vaibhav Nadgaonkar

Amit Shanbaug
Editor.

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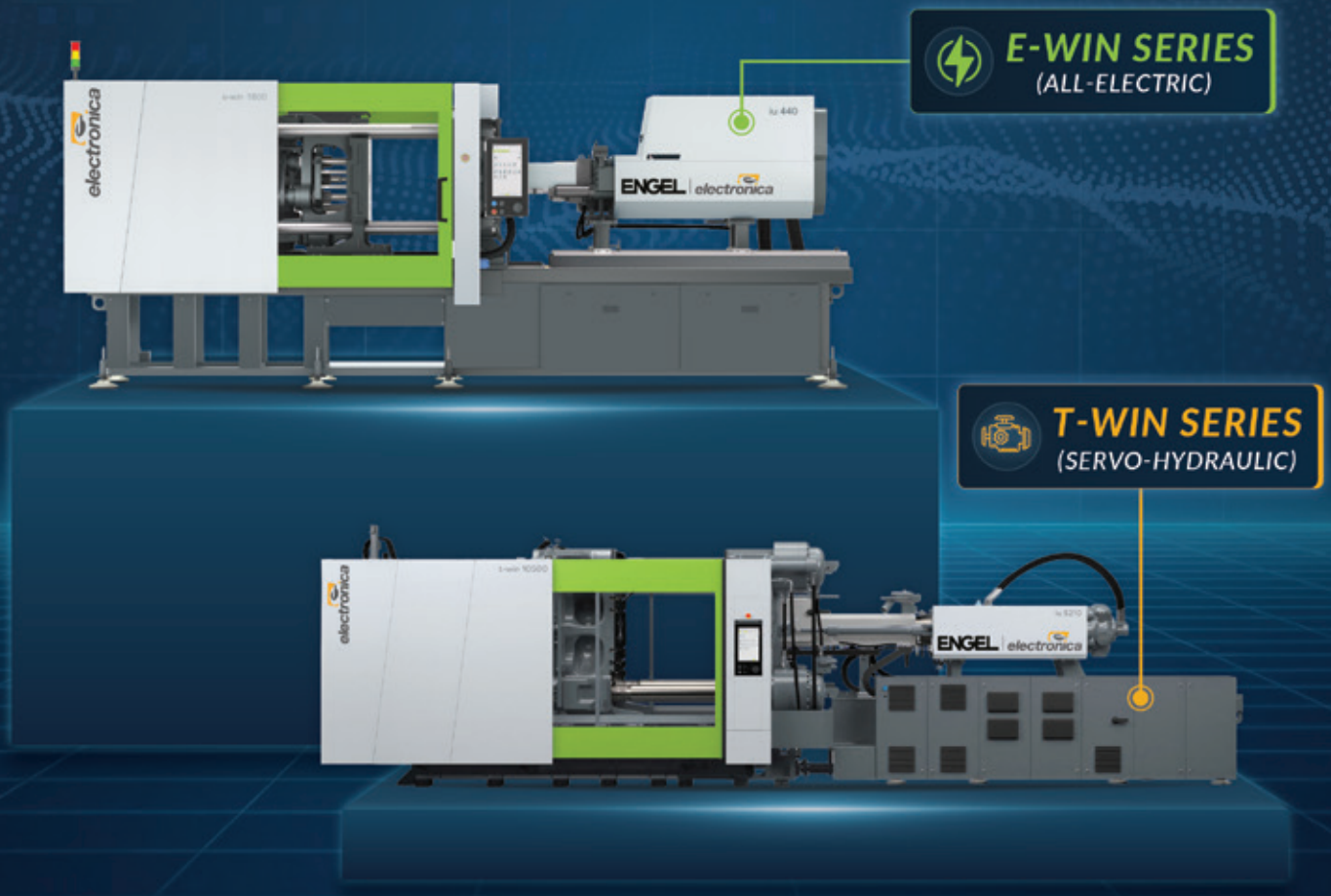

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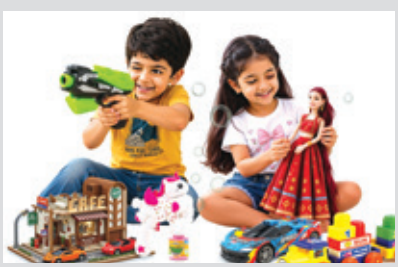

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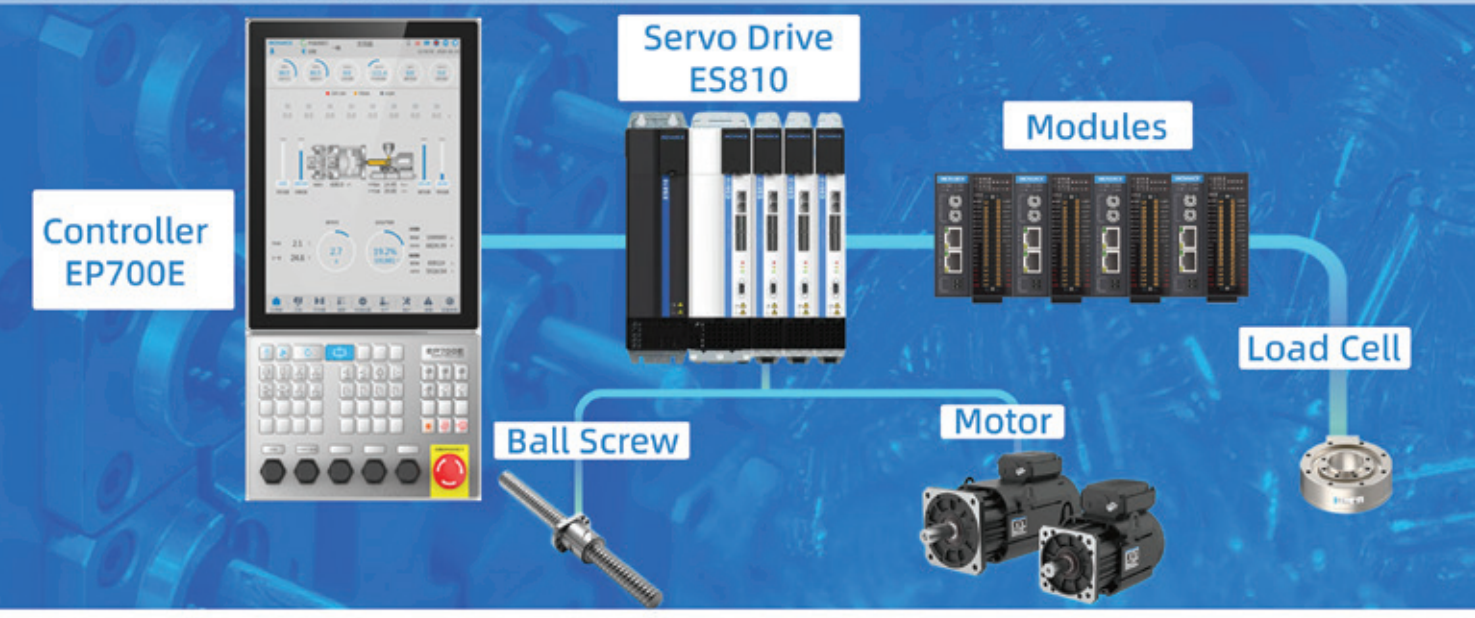

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Carbon Neutral Manufacturing Gains Momentum

Henkel's latest milestone highlights how electrification and renewable energy are helping manufacturers accelerate their decarbonisation efforts.

By Team ET Now Polymers

The push towards cleaner manufacturing is gathering pace across industries, and the latest example comes from **Henkel,** which has achieved carbon neutral production at its facilities in **Kurkumbh, India, and Gebkim, Türkiye.** The development reflects a broader trend among manufacturers seeking to reduce emissions through electrification and renewable energy adoption.

Industrial operations have traditionally depended on fossil fuels for heating and production processes, making manufacturing one of the more challenging sectors to decarbonise. However, advances in electric heating technologies and greater access to renewable power are enabling companies to rethink how factories operate.

At its Kurkumbh facility in Maharashtra, Henkel replaced furnace oil based heating systems with electric alternatives and transitioned the site to renewable electricity. The changes eliminated approximately **11,300 tonnes of carbon dioxide** equivalent emissions annually from the plant's operations.

A similar approach was adopted at the company's Gebkim facility in Türkiye, where a natural gas fired boiler was replaced with an electric boiler system. The move reduced annual emissions by around 956 tonnes of carbon dioxide equivalent while eliminating the site's direct dependence on fossil fuels.

The significance of these projects goes beyond the numbers. They demonstrate that technologies capable of supporting fossil fuel free manufacturing are already available and can be implemented at scale. As energy costs, regulatory pressures, and sustainability expectations continue to evolve, more manufacturers are exploring similar pathways to reduce their environmental footprint.

Electrification is emerging as one of the most effective tools in this transition. By replacing conventional fuel based systems with electric equipment and sourcing electricity from renewable energy, manufacturers can significantly lower operational emissions while improving energy efficiency. The approach also aligns with the growing adoption of solar power and certified green energy across industrial facilities worldwide.

For the plastics, chemicals, and specialty materials sectors in particular, decarbonisation is becoming a strategic priority. Customers increasingly expect suppliers to demonstrate measurable progress on sustainability goals, while investors and regulators are placing greater emphasis on carbon reduction initiatives.

Henkel's achievement also highlights an important shift in how sustainability is viewed within manufacturing. Rather than being treated as a separate environmental initiative, it is increasingly becoming part of core business strategy. Companies are finding that investments in cleaner technologies can support long term competitiveness while reducing environmental impact.

As manufacturers work towards ambitious climate targets over the coming decade, examples such as Kurkumbh and Gebkim offer a glimpse of what the future may look like. While challenges remain, the successful transition of these facilities suggests that carbon neutral manufacturing is moving from aspiration to reality, setting a benchmark for industrial operations around the world.

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THE POLYMER PRICE SURGE

For many plastic manufacturers across India, the past few months have been a roller coaster ride, due to sharp rise in polymer prices with no warning signs amidst volatile market conditions.

By Team ET Now Polymers

Prices of key polymers, the raw materials used to make everything from food packaging and water bottles to medical equipment and automotive parts, have surged dramatically. Industry associations say some polymer grades have seen price increases of as much as **65 to 70 percent** within a matter of weeks, leaving businesses scrambling to cope.

The impact has been especially severe for small and medium enterprises, which form the backbone of India's plastics processing industry.

So, what caused this sudden shock?

The answer lies thousands of kilometres away. Ongoing tensions and conflict in West Asia disrupted the movement of oil, gas and petrochemical products through key global trade routes. Since polymers are made from petroleum-based feedstocks, any disruption in oil and petrochemical supplies quickly affects availability and pricing. Freight costs, insurance premiums and delivery times also rose sharply, adding further pressure on the supply chain.

For manufacturers, the speed of the increase was as alarming as the increase itself.

Many processors reported multiple price revisions within a single month. Products such as polypropylene, polyethylene, PVC and PET became significantly more expensive, making it difficult for companies to plan purchases or quote prices to customers.

The biggest challenge has been uncertainty.

A plastic processor that usually buys raw material every week can no longer predict what the next shipment will cost. As a result, many companies have reduced production, delayed orders or purchased only the quantities needed for immediate requirements. Some have even postponed expansion plans until prices stabilise.

For smaller businesses, the pressure is particularly intense. Raw materials often account for more than half of production costs. When prices jump suddenly, working capital requirements also rise. A company that needed Rs. 10 lakh to buy inventory a month ago may now need substantially more money for the same quantity of material.

The ripple effects are spreading across industries.

Manufacturers of packaging materials, footwear, household products, healthcare supplies and consumer goods have all been affected. Some businesses are absorbing the higher costs to retain customers, while others have begun increasing prices. In several regions, processing units have temporarily halted operations because the economics simply no longer work.

Yet the crisis is also forcing companies to rethink old habits.

Many manufacturers are diversifying suppliers, maintaining more flexible inventories and exploring recycled materials where possible. Others are investing in better demand forecasting and procurement planning to reduce exposure to sudden price swings.

The current polymer price shock is a reminder of how deeply connected Indian manufacturing is to global events. A conflict in one part of the world can quickly affect factories, workers and consumers thousands of kilometres away.

For now, businesses are focused on survival rather than growth. But the lessons learned during this period could help create stronger and more resilient supply chains in the years ahead.

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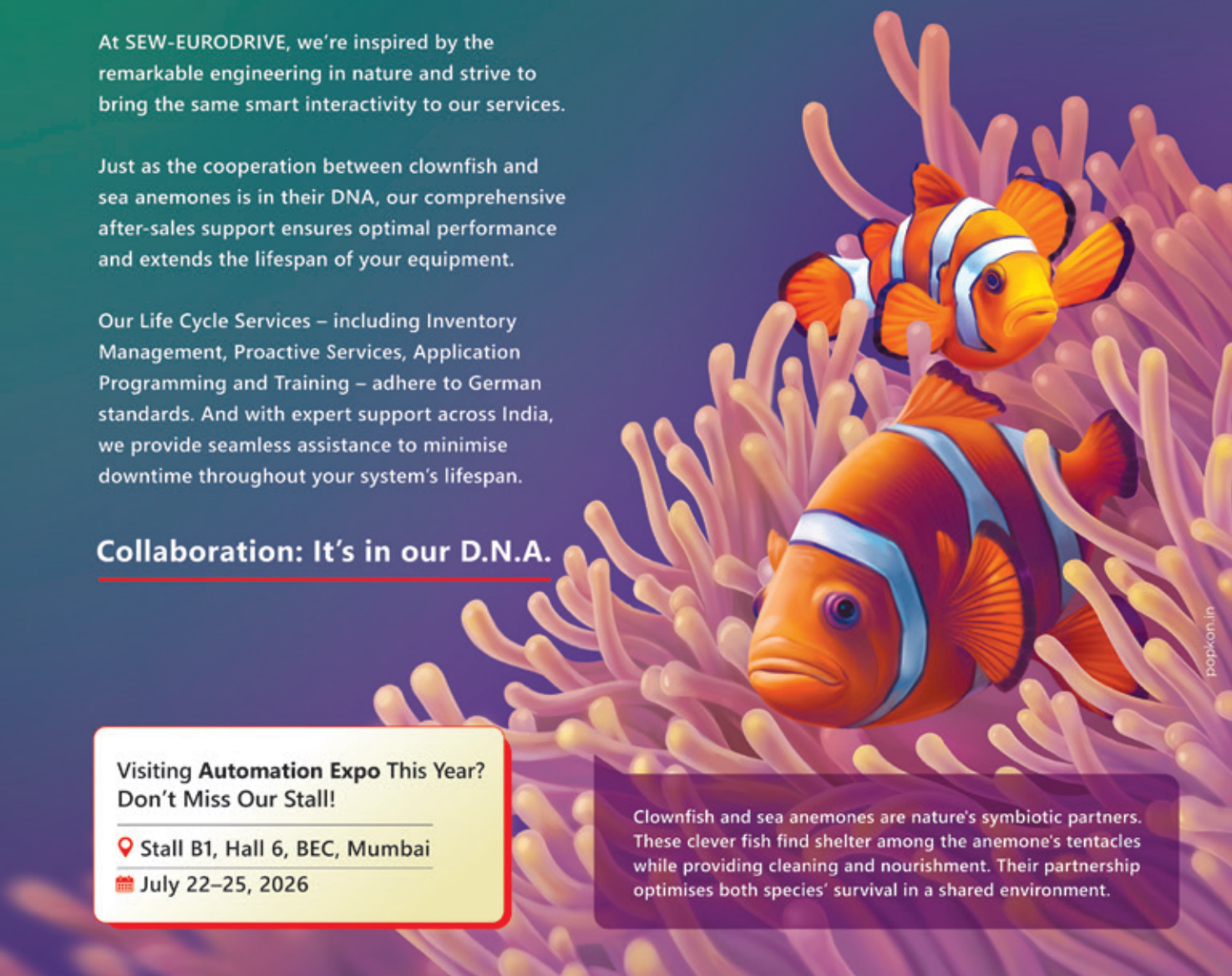

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CAN CHEMICAL RECYCLING FINALLY CLOSE THE LOOP FOR PLASTICS?

As plastic waste grows worldwide, chemical recycling is emerging as a promising way to turn difficult plastics into valuable new materials.

By Team ET Now Polymers

For decades, recycling has been seen as the answer to the world's plastic waste problem. Yet the reality has been disappointing. According to the **OECD,** global plastic production reached **460 million tonnes in 2019,** but only **9 percent** of plastic waste was ultimately recycled. Much of the rest ended up in landfills, incinerators, or the environment.

One reason is that traditional mechanical recycling has limits. It works best with clean and sorted plastic streams. However, many everyday products such as food wrappers, sachets, pouches, and multilayer packaging are difficult or impossible to recycle using conventional methods.

This is where chemical recycling is attracting growing attention.

Unlike mechanical recycling, which simply melts and reshapes plastic, chemical recycling breaks plastic down into its basic chemical building blocks. These materials can then be used to create new plastics that are close to virgin quality.

The technology is no longer just a laboratory concept. Around the world, companies, investors, and major consumer goods manufacturers are investing heavily in chemical recycling facilities. The goal is to create a circular system where plastics are reused again and again instead of becoming waste.

The appeal is easy to understand. Chemical recycling can process mixed and contaminated plastics that would otherwise be discarded. This could help tackle one of the biggest challenges facing the recycling industry today.

For consumer goods companies, the technology also offers a potential route to meet increasingly ambitious sustainability commitments. Many global brands have pledged to increase recycled content in their packaging, but finding enough high quality recycled material remains difficult.

The business opportunity is significant. The OECD reports that recycled plastics currently account for only about **6 percent** of total plastic feedstock globally. Expanding advanced recycling technologies could help increase that share and reduce dependence on virgin fossil-based materials.

Researchers are also making progress. New studies are exploring polymers designed specifically for chemical recycling, allowing materials to be broken down and recovered more efficiently. Some experimental systems have already demonstrated recovery rates of more than **90 percent** of the original material.

Yet chemical recycling is not a silver bullet.

Critics point out that some processes require large amounts of energy and can be expensive to operate. Environmental groups have also questioned whether certain technologies truly create a circular system, especially when plastics are converted into fuels rather than new plastics.

There are also concerns about emissions, economics, and scalability. While several commercial plants are now operating or under development, the industry still needs to prove that it can deliver environmental benefits at a scale large enough to make a meaningful impact.

Even so, momentum is building. Governments are tightening regulations on plastic waste. Investors are backing new technologies. Brands are looking for solutions that go beyond traditional recycling.

The bigger picture is clear. Plastic waste continues to grow faster than current recycling systems can handle. If chemical recycling can overcome its economic and environmental challenges, it could become a crucial part of the circular economy.

The question is no longer whether chemical recycling works. The question is whether it can scale fast enough to help solve one of the world's most pressing environmental problems.

For now, the answer remains uncertain. But for an industry searching for better ways to manage plastic waste, chemical recycling is rapidly moving from promise to reality.

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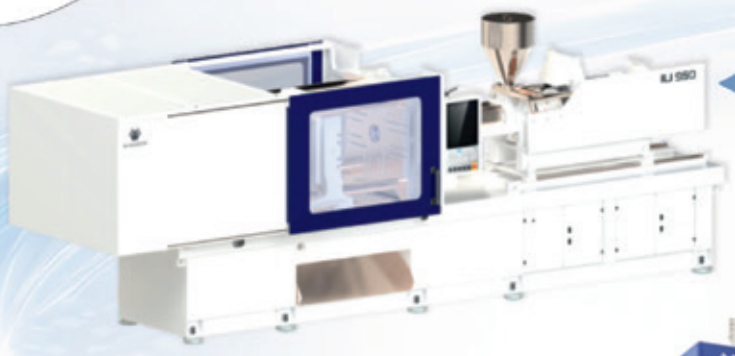

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EDIBLE INNOVATION, ZERO WASTE

An IIT Ropar-incubated startup is turning seaweed into edible, antimicrobial packaging that could redefine sustainable consumption

By Team ET Now Polymers

For generations, packaging has followed a predictable lifecycle: it serves its purpose for a few hours, days or weeks before being discarded, often remaining in the environment for decades. As concerns around plastic pollution, landfill waste and microplastics continue to grow, innovators around the world are searching for alternatives that are both practical and sustainable. One such solution is emerging from Punjab, where an IIT Ropar-incubated startup is reimagining packaging itself.

EdZero, a deep-tech venture incubated at IIT Ropar, has developed an edible, biodegradable and antimicrobial packaging material derived from seaweed. While the idea of eating a wrapper may sound futuristic, the technology is rooted in a simple principle: **packaging should protect products without becoming an environmental burden once its job is done.**

The startup's material is created using **naturally sourced seaweed-based biopolymers** combined with plant-derived antimicrobial compounds. The resulting film is designed to perform many of the functions associated with conventional packaging while offering a significantly smaller environmental footprint. Unlike traditional plastic packaging, which can persist in ecosystems for centuries and contribute to the growing problem of microplastic contamination, EdZero's packaging can be consumed, composted or naturally biodegraded.

What makes the innovation particularly compelling is its ability to address multiple challenges simultaneously. Sustainability is, of course, at the forefront. However, the material's antimicrobial properties also offer the potential to enhance food safety and preservation by helping reduce microbial growth. This dual functionality could prove valuable in an industry constantly seeking ways to extend shelf life while reducing reliance on synthetic materials and preservatives.

The potential applications extend far beyond novelty. EdZero envisions its technology being used across food and beverage packaging, single-use sachets, retail products, personal care items and even healthcare applications. In sectors where enormous volumes of disposable packaging are used every day, even a small shift towards biodegradable alternatives could have a meaningful environmental impact.

Perhaps the most important aspect of the innovation is that it has been developed with scalability in mind. Many sustainable materials struggle to move beyond laboratory success because they require entirely new manufacturing systems or are prohibitively expensive. EdZero's approach aims to integrate with existing packaging processes, increasing the likelihood of adoption by industry and making the transition away from conventional plastics more feasible.

The startup also reflects a broader trend within India's innovation ecosystem, where academic research is increasingly being translated into commercially viable solutions. Institutions such as IIT Ropar are becoming hubs for deep-tech entrepreneurship, fostering technologies that address pressing global challenges through locally developed innovation.

As governments, businesses and consumers grapple with the realities of plastic waste, the demand for sustainable alternatives is growing rapidly. EdZero's seaweed-based packaging offers more than just a greener material, it proposes a fundamentally different relationship with packaging itself. In a future shaped by circular economies and responsible consumption, the most sustainable package may be the one that leaves nothing behind at all.

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BUILT ON QUALITY

Through consistent quality, customised solutions and a strong focus on customer needs, Bharat Carbonates continues to strengthen its presence across industries.

By Team ET Now Polymers

In manufacturing, even the smallest component can make a big difference. The quality of a plastic product, a paint finish, a rubber compound or a sheet of paper often depends on the quality of the raw materials used. For industries that rely on calcium carbonate, consistency is not just important, it is essential.

That is where **Bharat Carbonates** has built its reputation.

The company supplies coated and uncoated calcium carbonate products to a wide range of industries, including plastics, paints, paper, rubber, pharmaceuticals and construction. Over the years, it has focused on delivering products that not only meet quality standards but also help customers improve performance and efficiency.

While calcium carbonate is widely used as a filler material, its effectiveness depends on how it is processed. Bharat Carbonates pays close attention to every stage of production, beginning with the selection of high quality limestone. Advanced grinding and classification systems ensure the required particle size, while regular testing helps maintain consistency across batches.

This focus on quality allows customers to rely on products that perform consistently in their manufacturing processes.

The company offers both coated and uncoated grades. Uncoated calcium carbonate is commonly used in applications such as PVC products, paper and construction materials. Coated calcium carbonate is designed for more demanding applications where better dispersion and improved compatibility are required.

For coated grades, Bharat Carbonates uses specialised surface treatment technology that enhances the material's performance in plastics, paints and other formulations. The result is improved processing, better product quality and greater formulation efficiency.

Its products are used across a variety of industries. In plastics, calcium carbonate helps improve filler distribution and supports cost effective production. Paint manufacturers benefit from improved whiteness and opacity, while rubber manufacturers use specialised grades to enhance strength and performance. The material is also widely used in adhesives, sealants and paper applications.

A key strength of the company is its customer centric approach. Bharat Carbonates works closely with customers through technical discussions, product trials and regular engagement to understand their specific requirements. This collaborative approach helps develop solutions that are practical and effective in real manufacturing environments.

The company is also investing in growth and sustainability. In 2025, it expanded its production capacity from 84,000 metric tonnes per year to **150,000 metric tonnes per year,** reflecting increasing demand across industries.

At the same time, Bharat Carbonates has taken steps to reduce its environmental footprint through investments in renewable energy, including a 2.1 MW wind power project and a 1.35 MW solar power facility.

As manufacturing industries continue to evolve, customers are increasingly looking for partners who can deliver quality, reliability and technical expertise. By combining strong manufacturing capabilities with a commitment to innovation and sustainability, Bharat Carbonates is positioning itself as more than just a supplier.

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RETHINKING PLASTICS IN TOY MANUFACTURING

From safety and durability to sustainability and innovation, material science is becoming a key driver of growth in the toy industry.

By Team ET Now Polymers

Toys today are doing far more than simply keeping children entertained. They are helping young minds learn, create, solve problems and develop critical skills from an early age. As parents increasingly seek products that combine education with play, the toy industry is undergoing a significant transformation. Manufacturers are expected to deliver products that are innovative, engaging and durable, while maintaining the highest standards of safety and affordability.

Amid these changing expectations, one factor often remains behind the scenes: the materials that make modern toys possible.

For decades, plastics and polymers have formed the backbone of toy manufacturing. Despite ongoing conversations around sustainability, these materials continue to play a vital role in helping manufacturers create products that are safe, versatile and cost effective. As the toy industry evolves, advancements in polymer technology are becoming just as important as innovations in design and functionality.

From building blocks and educational kits to puzzles, action figures and learning games, polymers are present in nearly every toy category. Their versatility allows manufacturers to create products in different shapes, colours and sizes while ensuring they can withstand repeated use. More importantly, they provide the flexibility needed to continuously innovate and meet changing consumer demands.

According to **Karan Narang, Managing Director of KV Toys India Limited,** material selection has become one of the most important aspects of modern toy manufacturing.

"In the toy industry, material selection goes far beyond manufacturing. The right polymer influences safety, durability, aesthetics and affordability. As toys become more sophisticated, the role of materials becomes even more important in delivering a quality experience for children," says Narang.

This is particularly relevant at a time when educational and STEM based toys are gaining popularity. Parents are increasingly looking for products that help children develop creativity, problem solving abilities and critical thinking skills. These toys often feature multiple components, interactive elements and more complex designs, creating greater demands on the materials used to manufacture them.

As a result, manufacturers are relying on advanced polymers that offer the right balance of strength, flexibility and impact resistance. Modern material innovations have enabled toy companies to create products that are more durable and visually appealing while maintaining strict safety standards.

At the same time, advancements in moulding technologies and material engineering have expanded

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the possibilities for product design. Improved polymers deliver better surface finishes, brighter colours and greater precision, allowing manufacturers to create toys that are more engaging for children while improving production efficiency.

However, innovation is only one part of the story. Over the last few years, the plastics and polymers industry has experienced considerable volatility. Supply chain disruptions, geopolitical uncertainties and fluctuations in crude oil prices have all contributed to rising raw material costs, creating challenges for manufacturers across sectors.

For toy manufacturers, these fluctuations can significantly impact production economics. Polypropylene, one of the most commonly used polymers in toy manufacturing, has seen substantial price increases in recent years. Managing these cost pressures requires manufacturers to constantly adapt their sourcing and operational strategies.

Many companies have responded by strengthening supplier relationships, diversifying procurement channels and improving inventory management practices. At the same time, there has been a renewed focus on manufacturing efficiencies, material optimisation and waste reduction. These efforts not only help manage costs but also contribute to more sustainable production processes.

Sustainability, of course, remains one of the most discussed topics within the plastics industry today. As environmental awareness grows, industries are under increasing pressure to evaluate the materials they use and explore more responsible manufacturing practices.

The toy sector is no exception. However, unlike many other categories, toy manufacturers must balance sustainability goals with stringent safety and performance requirements. Products designed for children must consistently meet high standards of durability, quality and compliance, making material selection particularly critical.

> "Polymers are at the heart of our product development and manufacturing strategy. In the toy industry, the choice of material directly impacts product safety, durability, aesthetics and cost competitiveness. As toys become more innovative and educational, material selection plays an increasingly important role in delivering quality products.
>
> **Karan Narang, Managing Director, KV Toys India**

While recycled plastics and alternative materials continue to attract interest, their adoption in mass market toy manufacturing presents several challenges. Consistency, aesthetics, durability and safety remain key considerations, particularly in products intended for young children.

Narang believes the conversation around plastics is becoming more balanced and practical.

"The focus should be on responsible material usage and manufacturing practices. In categories such as toys, where safety and durability are critical, polymers continue to offer advantages that are difficult to replace at scale. The industry's challenge is to balance performance, affordability and sustainability in a practical way," he says.

This shift in perspective is encouraging manufacturers to focus on smarter material usage rather than viewing plastics as a one-dimensional issue. Improving material efficiency, reducing waste and exploring future alternatives are increasingly becoming part of a broader sustainability strategy.

The evolution of the plastics industry also aligns closely with India's emergence as a global manufacturing destination. The country has developed strong fundamentals, including a large domestic market, a skilled workforce and growing manufacturing capabilities. Government initiatives promoting local manufacturing have further strengthened India's position in global supply chains.

For the toy industry, this presents a significant opportunity. As international buyers look to diversify sourcing destinations, India is increasingly being viewed as a credible manufacturing hub. However, continued investment in automation, advanced tooling, product design and supply chain infrastructure will be essential to sustaining this momentum.

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PACKAGING'S NEW IDENTITY CARD

A simple scan could soon reveal where packaging came from, what it contains, and how it should be recycled.

By Team ET Now Polymers

Imagine buying a bottle of water and being able to scan a code on the label to instantly learn where the packaging was made, what materials were used, how much recycled content it contains, and how it should be disposed of after use.

That future is rapidly becoming reality through **Digital Product Passports,** often referred to as DPPs.

A Digital Product Passport is essentially a digital identity card for a product or its packaging. It stores important information about materials, manufacturing, environmental impact, recycled content, compliance data and end of life management. The information can usually be accessed through a QR code or another digital marker placed on the packaging.

While the concept may sound technical, its purpose is straightforward. It aims to make products and packaging more transparent, traceable and sustainable.

The push is being driven largely by Europe, where regulators are introducing some of the most ambitious circular economy policies in the world. As these regulations take effect, companies across global supply chains, including many in India, will need to adapt.

The need for greater transparency is becoming increasingly urgent. Packaging remains one of the largest users of plastics globally. According to the **European Commission,** around **40 percent** of all plastics used in Europe are consumed by packaging applications. Packaging is also responsible for a significant share of waste generation, with each European citizen generating approximately **186.5 kilograms** of packaging waste annually. These figures have strengthened the case for better tracking and management of packaging throughout its lifecycle.

This is where Digital Product Passports enter the picture.

A typical passport can contain information about the packaging material, polymer type, recycled content, manufacturing location, certifications, compliance records and recycling instructions. Instead of relying solely on printed labels, all this information becomes digitally accessible through a simple scan.

For brand owners, regulators and consumers, the benefits are substantial. Consumers gain greater visibility into the products they purchase. Regulators can verify compliance more efficiently. Manufacturers can improve supply chain transparency and simplify reporting requirements.

At the heart of the initiative is the European Union's broader sustainability agenda. The **Packaging and Packaging Waste Regulation** entered into force in **February 2025** and begins general application

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ET NOW POLYMERS 10th EDITION Global Conference on Plastics in Automotive

Theme:

LOCAL INNOVATION, GLOBAL IMPACT, SUSTAINABLE MOBILITY

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from **August 2026.** The regulation aims to make all packaging placed on the European market recyclable in an economically viable manner by **2030** while increasing the use of recycled plastics and reducing dependence on virgin raw materials.

Although the regulation does not mandate a Digital Product Passport for every packaging application today, it increasingly relies on digital information systems, machine readable labels and traceability tools that closely align with the DPP framework. Many industry experts believe Digital Product Passports will become a key mechanism for meeting future compliance requirements.

For the plastics and polymers industry, the implications are significant.

For decades, packaging supply chains have operated with limited visibility. Information about material composition, additives, recycled content and sourcing often remains fragmented across suppliers, converters and brand owners. Digital Product Passports aim to connect these information gaps.

Consider a flexible packaging pouch. Through a Digital Product Passport, stakeholders could access details about the resin grade used, the percentage of recycled content, barrier layer specifications, manufacturing location and recycling recommendations. Such visibility can improve recycling outcomes and support circular economy objectives.

The technology could also help address one of the industry's biggest challenges: proving sustainability claims.

As environmental regulations become stricter, companies are increasingly required to demonstrate the accuracy of claims relating to recyclability, recycled content and environmental performance. Digital Product Passports provide a structured way to store and share this information across the value chain.

For Indian exporters, the development deserves close attention.

India is a major supplier of packaging materials, flexible films, plastic products and consumer goods to international markets. Companies exporting to Europe may soon find that digital traceability is no longer optional but an essential requirement for market access.

Industry observers warn that businesses that fail to prepare for Digital Product Passport requirements could face compliance risks and even lose access to certain export opportunities in the future. At the same time, companies that adopt digital traceability early may gain a competitive advantage.

The benefits extend beyond compliance.

Digital Product Passports can help improve inventory management, product authentication and supply chain efficiency. They can also support recycling companies by providing accurate information about material composition, making sorting and recovery more effective.

Some companies are already exploring how passports can create stronger engagement with consumers. A simple scan could provide information on sustainability performance, certifications, product origin and disposal guidance. In the future, packaging may become an active source of information rather than merely a container.

Of course, challenges remain.

Many companies still struggle with fragmented data systems and inconsistent supplier information. Collecting accurate data across multiple tiers of suppliers is often complex and time consuming. Questions around data ownership, interoperability and standardisation also remain under discussion.

Industry experts note that technology is not the biggest hurdle. The real challenge lies in organising, verifying and maintaining high quality data throughout the product lifecycle.

Despite these challenges, momentum is clearly building.

The conversation is no longer about whether digital transparency will become part of packaging. The conversation is about how quickly companies can prepare for it.

For the plastics and packaging industry, Digital Product Passports represent far more than a regulatory requirement. They represent a shift towards a future where every package carries a digital identity, every material can be traced and every sustainability claim can be verified.

In a world increasingly focused on circularity, accountability and resource efficiency, packaging's next evolution may not be visible on the surface. It may be hidden behind a simple scan.

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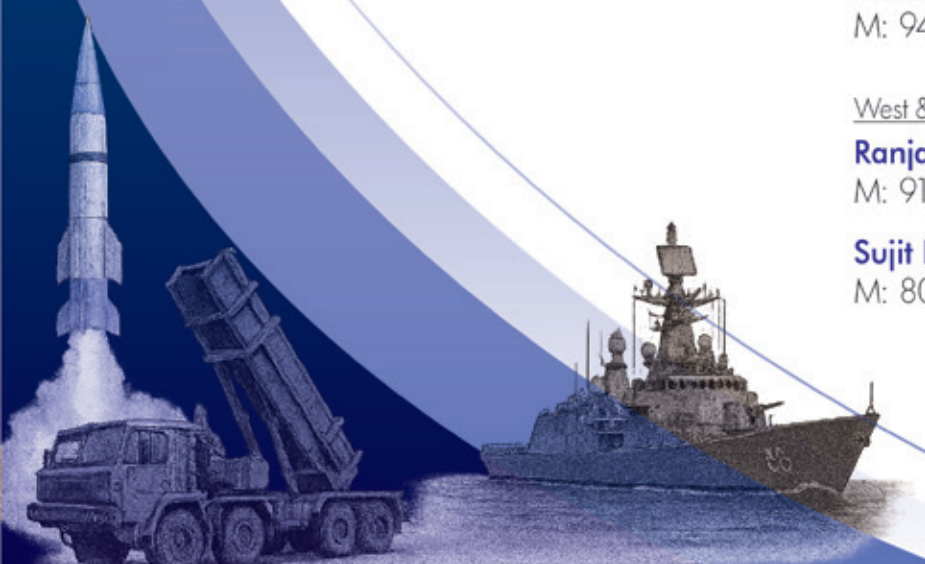

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THE PRICE OF UNCERTAINTY

From wars and energy volatility to supply chain disruptions, the world's crises are reshaping polymer costs and industrial growth.

By Team ET Now Polymers

The global plastics and polymers industry has always been closely linked to the health of the world economy. From crude oil and natural gas to manufacturing, logistics, retail, healthcare, automotive, construction, and packaging, polymers sit at the centre of modern industrial activity. Today, however, the industry finds itself navigating one of the most challenging periods in recent memory.

A combination of geopolitical conflicts, energy market volatility, supply chain disruptions, trade tensions, inflationary pressures, environmental regulations, and shifting consumer expectations is creating unprecedented uncertainty across the plastics value chain. The result is rising polymer costs, fluctuating availability of raw materials, pressure on manufacturers, and growing concerns among end users across multiple industries.

While the plastics industry has weathered crises before, the current environment is different because several challenges are occurring simultaneously. The impact is being felt from petrochemical complexes in the Middle East to packaging converters in India, from automotive manufacturers in Europe to consumer goods companies in North America.

The global plastics industry is enormous in scale. According

to OECD data, global plastics production and use reached approximately **435 million tonnes in 2020** and is expected to continue growing in the coming decades. Industry estimates place annual global plastics production at more than **430 million tonnes,** underlining the material's importance to modern economies.

The Energy Crisis and Rising Polymer Costs

One of the biggest drivers of polymer price volatility is the energy market.

Most conventional polymers originate from petrochemical feedstocks derived from crude oil and natural gas. Polyethylene, polypropylene, polystyrene, polyvinyl chloride, and several engineering plastics are all linked directly or indirectly to hydrocarbon markets. Whenever oil and gas prices rise sharply, the cost of producing polymers tends to increase as well.

Over the past few years, energy markets have experienced repeated shocks. The Russia Ukraine conflict disrupted global gas flows and significantly altered energy economics, particularly in Europe. More recently, tensions in the Middle East have created fresh uncertainty around oil supplies, shipping routes, and feedstock availability.

The impact extends far beyond feedstock costs. Petrochemical plants consume large amounts of electricity and thermal energy. As energy prices increase, production costs rise across the value chain. European chemical producers, for example, continue to face significantly higher energy costs compared with competitors in the United States and parts of the Middle East. Industry reports indicate that European gas prices remained around two and a half times higher than those in the United States through much of **2025,** creating a major competitiveness challenge.

For polymer manufacturers, this translates directly into margin pressure. For converters and processors, it means higher raw material prices. For brand owners and consumers, it often results in more expensive products.

Geopolitical Conflicts and Supply Chain Disruptions

The plastics industry depends on a highly interconnected global supply chain.

Feedstocks may originate in the Middle East, be processed into polymers in Asia, converted into packaging in India, and ultimately sold in Europe or North America. Any disruption along this chain can create ripple effects across multiple industries.

The Red Sea crisis highlighted just how vulnerable global logistics networks remain. The Suez Canal handles a significant share of global trade, including container shipments carrying polymers, chemicals, packaging materials, and finished products. According to the United Nations Conference on Trade and Development, around **12 to 15 percent** of global trade moves through the Suez Canal, while approximately **20 percent** of global container trade depends on the route. Disruptions have led to longer transit times, higher freight rates, and increased inventory costs.

For polymer buyers, these disruptions often result in delayed deliveries, supply shortages, and higher procurement costs. Small and medium sized manufacturers are particularly vulnerable because they often lack the purchasing power needed to secure long term contracts or maintain large inventories.

Recent reports from industry associations in India have highlighted how geopolitical tensions in West Asia have contributed to significant increases in polymer prices, creating serious challenges for processors and converters.

The Challenge of Global Overcapacity

Interestingly, rising costs are only one part of the story.

At the same time that many producers are facing higher operating expenses, the global petrochemical industry is also dealing with excess production capacity. Large investments in new petrochemical complexes, particularly in China and the Middle East, have added significant volumes of polymer production to the market.

This has created an unusual situation. While energy costs and logistics expenses are increasing, polymer producers are simultaneously facing intense competition and downward pressure on margins due to oversupply.

Industry analysts have repeatedly pointed to global overcapacity as one of the key challenges facing petrochemical producers. Weak demand growth in sectors such as construction, automotive, and consumer goods has further intensified pressure on profitability.

For buyers, oversupply can occasionally provide short term pricing relief. However, it also creates uncertainty regarding investment decisions, plant closures, and future supply security.

Impact on Packaging

No sector illustrates the importance of polymers more clearly than packaging.

Packaging remains the largest consumer of plastics globally. Flexible packaging, rigid containers, films, labels, closures, and protective packaging all depend heavily on polymer materials.

When polymer prices rise, packaging manufacturers experience immediate cost increases. Since packaging is used across food, beverage, pharmaceutical, personal care, and consumer goods sectors, the effects quickly spread throughout the economy.

Many packaging converters operate on relatively thin margins. Sudden increases in polyethylene or polypropylene prices can significantly affect profitability, particularly when customer contracts limit the ability to pass costs through immediately.

At the same time, packaging producers face growing sustainability requirements. Regulations such as the **European Union's Packaging** and **Packaging Waste Regulation** are accelerating the shift toward recyclable packaging, recycled content, and circular economy practices. Companies must therefore invest in innovation while simultaneously managing cost pressures.

Impact on the Automotive Industry

Modern vehicles contain substantial amounts of plastic materials.

Polymers are used in dashboards, bumpers, interiors, fuel systems, electrical components, lighting systems, and increasingly in electric vehicle applications where lightweighting is critical.

Rising polymer costs increase production expenses for vehicle manufacturers and suppliers. At a time when the automotive industry is already dealing with electrification investments, supply chain restructuring, and economic uncertainty, higher material costs add another layer of complexity.

Engineering plastics, specialty compounds, and performance materials are particularly sensitive because they often require sophisticated manufacturing processes and specialized feedstocks.

Automotive suppliers are therefore under growing pressure to improve material efficiency while maintaining performance and safety standards.

Impact on Construction and Infrastructure

Construction remains another major consumer of plastic products.

Pipes, fittings, insulation materials, flooring, roofing membranes, cables, windows, and water management systems all depend on polymers.

The construction sector is highly sensitive to economic cycles. Rising interest rates, inflation, and slower economic growth in several regions have already reduced construction activity. Higher polymer costs further increase project expenses.

For infrastructure developers and contractors, this can affect project feasibility and timelines. For manufacturers of construction materials, it creates additional pressure to balance cost competitiveness with product quality.

Healthcare and Essential Applications

Not all impacts are negative.

The healthcare sector continues to demonstrate the critical importance of plastics in modern society. Medical devices, syringes, intravenous bags, diagnostic equipment, pharmaceutical packaging, and countless other healthcare products rely on polymers.

Even during periods of economic uncertainty, demand for many medical applications remains relatively stable. This provides an important source of resilience for parts of the polymer industry.

However, healthcare manufacturers are not immune to rising costs. Increased prices for specialty polymers and packaging materials ultimately affect procurement budgets and healthcare supply chains.

Sustainability Pressures and Regulatory Change

Alongside economic challenges, the plastics industry faces growing environmental scrutiny.

Governments around the world are introducing regulations aimed at reducing waste, increasing recycling rates, encouraging recycled content, and limiting certain forms of single use plastics.

At the international level, discussions around a global plastics treaty continue to shape industry expectations. Meanwhile, major markets such as the European Union are implementing increasingly stringent sustainability requirements.

These changes require substantial investment in recycling infrastructure, product redesign, traceability systems, and compliance processes. While many companies view sustainability as an opportunity, the transition also creates short term costs and operational complexity.

The challenge for the industry is balancing environmental responsibility with economic competitiveness.

The Indian Perspective

India occupies a unique position in the global plastics landscape.

The country has emerged as a major manufacturing hub for packaging, films, consumer goods, automotive components, and plastic products. Its domestic market continues to grow rapidly while

exports remain an important source of demand.

However, Indian processors remain heavily exposed to global raw material trends. Changes in crude oil prices, freight rates, geopolitical tensions, and international trade flows can quickly influence domestic polymer markets.

Small and medium enterprises often face the greatest challenges because raw material costs account for a significant share of production expenses. Sudden price spikes can disrupt working capital cycles and reduce profitability.

At the same time, Indian companies that invest in recycling, sustainability, advanced materials, and supply chain resilience may find themselves well positioned to capture future opportunities as global customers seek reliable and compliant partners.

The Future Ahead

The global plastics and polymers industry is entering a period of profound transformation.

The sector must navigate energy volatility, geopolitical uncertainty, changing trade patterns, environmental regulations, technological innovation, and shifting consumer expectations all at once. Polymer prices are likely to remain sensitive to developments in energy markets and global supply chains, while competition and sustainability pressures will continue reshaping investment decisions.

Yet the long-term outlook for polymers remains significant. Plastics continue to play an essential role in packaging, healthcare, transportation, construction, renewable energy, electronics, and countless other applications. The challenge is not whether plastics will remain important, but how the industry adapts to a world demanding greater efficiency, resilience, transparency, and sustainability.

For manufacturers, converters, recyclers, and brand owners, the message is clear. The future belongs to companies that can manage volatility, embrace innovation, strengthen supply chains, and align with the evolving expectations of regulators, customers, and society. In a world defined by uncertainty, resilience may become the most valuable material of all.

PACKING BEYOND PLASTIC

From seaweed and fungi to advanced bio polymers, a new generation of materials is reshaping the future of packaging.

By Team ET Now Polymers

For decades, plastic has been the undisputed king of packaging.

It is lightweight, durable, cost effective, and versatile enough to be used across industries ranging from food and beverages to pharmaceuticals and consumer goods. Yet the very qualities that made plastic successful have also created one of the world's biggest environmental challenges.

Today, the packaging industry stands at a turning point. What was once viewed as a sustainability conversation is rapidly becoming a business imperative. Governments are introducing stricter regulations, consumers are demanding environmentally responsible products, and brands are under growing pressure to reduce their environmental footprint.

As a result, the next decade could witness one of the most significant material transitions in the history of packaging.

According to recent global sustainable packaging outlook reports, sustainable packaging is moving from a niche category to a mainstream requirement across industries. The global packaging industry is valued at more than **$1 trillion,** making it one of the largest manufacturing sectors in the world. Increasingly, the focus is shifting towards materials that are renewable, recyclable, compostable, or capable of supporting a circular economy.

At the heart of this transformation is a simple question: what comes after conventional plastic?

The answer may not be a single material. Instead, it is likely to be a portfolio of innovative solutions designed for different applications.

One of the most promising categories is bio-based polymers.

Unlike conventional plastics derived from fossil fuels, bio-based polymers are produced from renewable sources such as corn, sugarcane, starch, and other plant-based feedstocks. Materials such as **PLA** and **PHA** are attracting increasing attention because they offer many of the functional benefits of traditional plastics while reducing dependence on fossil resources. Industry forecasts suggest that bio plastics will continue to grow faster than the broader plastics market over the coming decade as regulations tighten and production scales improve.

Another material family gaining momentum is fibre-based packaging.

Paper, board, moulded pulp, and cellulose based materials are increasingly becoming the preferred choice for brands seeking sustainable alternatives. Improvements in coating technologies and barrier performance are enabling fibre-based packaging to be used in applications that were once dominated by plastic. This is particularly important for food, beverage, and pharmaceutical packaging, where product protection and shelf life remain critical requirements.

Perhaps even more fascinating are some of the emerging materials moving from laboratories into commercial trials.

Seaweed based packaging has become one of the most talked about innovations in recent years. Seaweed offers several sustainability advantages. It grows rapidly, does not require agricultural land, freshwater, or fertilizers, and can be processed

into films and coatings that provide effective barriers against moisture and oxygen. Several startups and global brands are already exploring seaweed-based alternatives for packaging applications.

Then there is mycelium.

Mycelium is the root like structure of fungi and is increasingly being explored as a packaging material. Researchers have demonstrated that mycelium can be grown using agricultural waste and other biomass to create strong, lightweight, biodegradable packaging solutions. In India, researchers at **IIT Madras** have developed mycelium-based packaging materials using agricultural waste, highlighting the potential of this technology to address both plastic pollution and waste management challenges.

While these materials may sound futuristic, another major shift is already happening today through the rise of recyclable mono material packaging.

Traditionally, many packaging formats have relied on multilayer structures that combine different materials to achieve strength, flexibility, and barrier performance. While effective, these structures are often difficult to recycle because separating the layers can be challenging.

The industry is increasingly moving towards mono material solutions that use a single material family while still delivering the required performance. Advances in coatings, adhesives, and barrier technologies are making these solutions commercially viable. This trend is expected to play a significant role in improving recyclability and supporting circular economy goals.

Technology is also accelerating innovation at an unprecedented pace.

Artificial intelligence and advanced materials research are helping scientists identify new polymer combinations that deliver both performance and recyclability. Recent research has demonstrated how machine learning can rapidly evaluate millions of potential polymer candidates, significantly reducing the time required to discover next generation packaging materials.

Of course, the journey is not without challenges.

Many sustainable materials still face cost pressures. Composting infrastructure remains limited in several regions. Recycling systems continue to evolve, and manufacturers must balance sustainability goals with performance, safety, and affordability requirements.

Yet despite these challenges, the direction of travel is becoming increasingly clear.

Regulatory frameworks across major economies are encouraging recyclable and sustainable packaging solutions. **Extended Producer Responsibility** regulations are creating stronger incentives for circular packaging systems. Brand owners are making ambitious commitments around recycled content, carbon reduction, and sustainable sourcing. Consumers are rewarding companies that demonstrate genuine environmental responsibility.

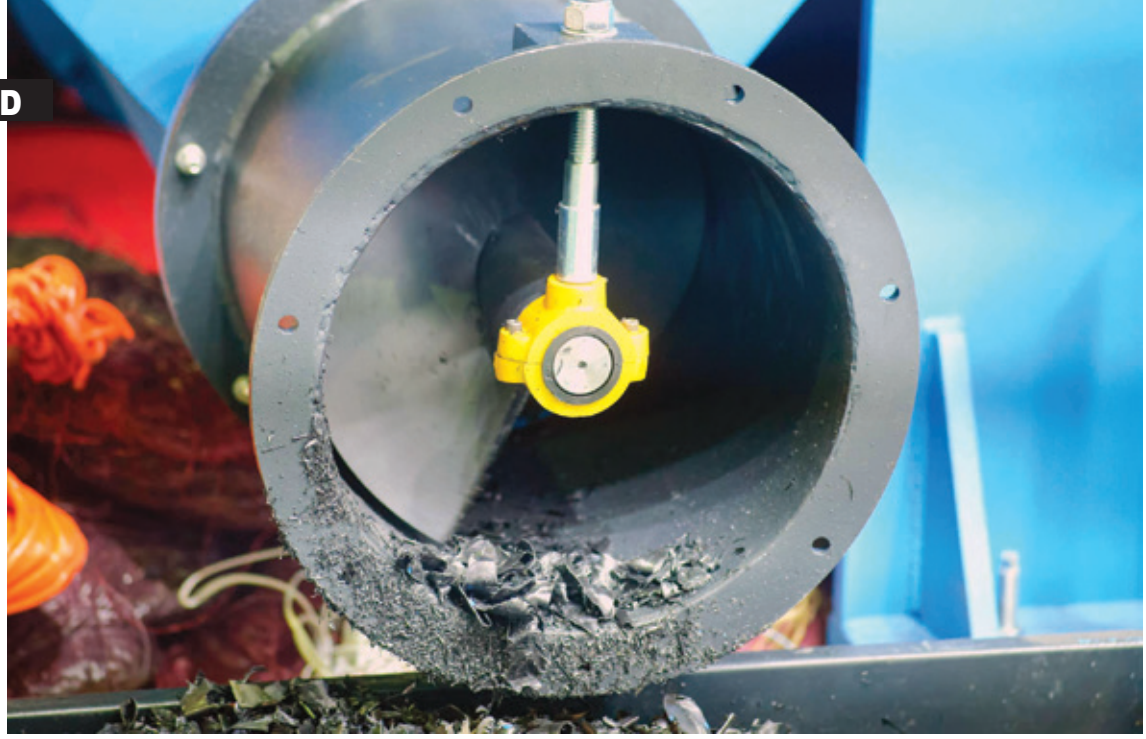
The future of packaging will not be defined by a single breakthrough material replacing plastic overnight.

Instead, it will be shaped by a combination of smarter materials, better design, improved recycling systems, and a growing commitment to circularity.

From bio polymers and fibre-based solutions to seaweed films, mycelium composites, and recyclable mono material structures, the next generation of packaging materials is already emerging.

The question is no longer whether packaging will change.

The question is how quickly these new materials can scale to meet the demands of a world that expects sustainability to be built into every package.



HOW EPR IS POWERING INDIA'S CIRCULAR MANUFACTURING REVOLUTION

What began as a compliance requirement is now driving investment, innovation, and a new generation of recycling businesses across India.

By Team ET Now Polymers

For years, waste management was seen as someone else's problem. Companies made products, consumers used them, and municipalities dealt with the waste. That model is rapidly changing in India.

Today, Extended Producer Responsibility, or EPR, is reshaping the country's packaging and recycling industry. What started as an environmental regulation is now becoming a powerful business driver, creating opportunities for entrepreneurs, investors, recyclers, and manufacturers alike.

The idea behind EPR is simple. If a company puts plastic packaging into the market, it must take responsibility for collecting and processing an equivalent amount of waste. In practice, however, this has created an entirely new ecosystem of businesses focused on waste collection, recycling, traceability, and material recovery.

The timing could not be more important.

India generated more than 4.1 million tonnes of plastic waste in 2020 and 2021, according to data from the Central Pollution Control Board. At the same time, consumption of packaged goods continues to rise, increasing pressure on waste management systems across the country.

This challenge is creating new opportunities.

Under India's EPR framework, producers, importers, and brand owners must meet collection and recycling targets through a centralised compliance system. Companies are increasingly partnering with authorised recyclers and waste processors to fulfil these obligations.

As a result, investment is flowing into recycling technologies that were once considered niche.

One area attracting significant attention is flexible packaging. Items such as snack wrappers, pouches, sachets, and multilayer packaging have traditionally been difficult to recycle. Many ended up in landfills or were burned because conventional recycling systems struggled to process them efficiently.

Today, several startups are developing technologies specifically designed to recover value from these complex waste streams. Their solutions range from advanced sorting systems and material recovery processes to chemical recycling technologies capable of converting difficult plastics into reusable raw materials.

The shift is changing how investors view the recycling sector.

Previously, waste management was often seen as a low growth industry. EPR has altered that perception. As compliance requirements become more stringent, demand for reliable recycling capacity continues to increase. This has created a stronger business case for innovation and expansion.

The numbers highlight the scale of the opportunity.

The total EPR obligation of registered producers, importers, and brand owners for plastic packaging reached approximately 3 million tonnes in 2022 and 2023. During the same period, registered plastic waste processors generated EPR certificates for around 2.5 million tonnes of processed plastic packaging waste.

Recycling is also becoming more sophisticated.

Brand owners are no longer looking only for waste collection. They increasingly want traceability, verified recycling records, and access to recycled content that can be incorporated into new packaging. This is encouraging the development of digital tracking platforms and more transparent supply chains.

The next phase of EPR is expected to accelerate this trend even further.

India's regulations are gradually increasing recycling targets across different categories of plastic packaging. In addition, recycled content requirements are becoming more important, encouraging companies to use more recycled material in their products rather than relying solely on virgin plastic.

This creates a powerful incentive for innovation. Recyclers are no longer competing only on price. They are competing on quality, traceability, technology, and their ability to deliver materials that meet the standards of major consumer brands.

For entrepreneurs, the opportunity extends far beyond recycling plants. Businesses focused on waste collection networks, digital compliance systems, sorting technologies, recycled materials, and circular manufacturing solutions are all finding new avenues for growth.

Of course, challenges remain. Collection systems need to become more efficient. Informal waste workers must be better integrated into the formal economy. Verification and transparency will also be critical to maintaining confidence in the EPR system.

Yet the direction of travel is clear.

India's plastic waste challenge remains enormous, but EPR is helping transform how the country approaches the problem. Instead of treating waste as a burden, the policy is encouraging businesses to see it as a resource.

That shift in thinking may ultimately be EPR's greatest achievement.

The real story is no longer about compliance. It is about innovation, investment, and the emergence of a new generation of circular manufacturing companies that are turning waste into economic value.

In the years ahead, some of India's most successful sustainability businesses may not be those that make products. They may be the ones that give those products a second life.

> "India's EPR framework is transforming plastic waste management into a thriving business opportunity. With a robust investment, recycling technologies, and circular manufacturing intiatives, stakeholders are turning waste into valuable resources for sustainable growth.

WORKFORCE CRUNCH HITS GLOBAL PLASTICS INDUSTRY

As manufacturing becomes more technology driven, plastics companies worldwide are struggling to find the skilled talent needed for future growth.

By Team ET Now Polymers

The global plastics industry is facing a workforce challenge that is rapidly becoming one of the sector's most pressing concerns. While manufacturers continue to invest in automation, sustainability initiatives, and advanced production technologies, many are finding it increasingly difficult to recruit and retain the skilled workers needed to operate modern facilities.

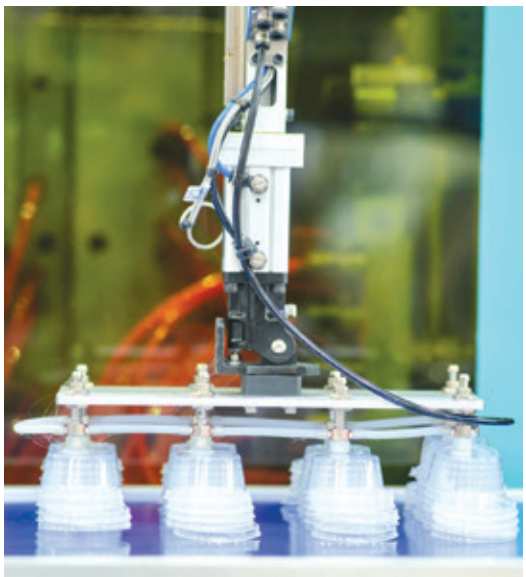
Recent findings from the **ZipDo Education Report 2026: Upskilling and Reskilling in the Plastics Industry** reveal the scale of the problem. According to the report, **62 percent** of plastics manufacturers are having trouble in finding skilled technicians, while **45 percent** report shortages in advanced manufacturing skills. These figures reflect a growing mismatch between the skills companies' need and the talent available in the labour market.

The issue extends well beyond any single country or region. Plastics manufacturers across North America, Europe, and Asia are reporting similar challenges as they compete for qualified workers in an increasingly tight labour market. Industry leaders say the shortage is affecting a wide range of positions, from machine operators and maintenance technicians to engineers, automation specialists, quality control experts, and production managers.

One of the key drivers behind the shortage is demographic change. A significant portion of the manufacturing workforce is approaching retirement age, creating a wave of vacancies that companies are struggling to fill. At the same time, fewer young people are choosing careers in manufacturing, often opting instead for opportunities in technology, finance, or service industries.

The challenge is particularly evident in the United States, where industry economists continue to warn about a widening manufacturing skills gap. Data released by the **Plastics Industry**

Association shows that despite ongoing economic uncertainty, approximately **462,000** manufacturing positions remained unfilled in **early 2026.** The shortage has persisted even as companies increase wages, improve benefits, and expand recruitment efforts.



The labour shortage is especially concerning because the plastics industry remains a major contributor to the economy. The sector supports more than **1.06 million** direct jobs in the United States and generates over **US$550 billion** in annual shipments. When related industries and suppliers are included, total employment linked to plastics rises to around **1.71 million** jobs. These figures highlight the importance of maintaining a strong workforce pipeline to support future growth and competitiveness.

Manufacturing itself has changed dramatically over the past decade. Today's plastics processing plants bear little resemblance to the factories of the past. Modern facilities increasingly rely on robotics, automated production systems, digital monitoring tools, predictive maintenance technologies, and sophisticated quality control processes. As a result, employers are seeking workers with a blend of technical knowledge, problem solving abilities, and digital skills.

This transformation has created a growing demand for expertise in areas such as automation, data analysis, process optimisation, equipment maintenance, and advanced manufacturing operations. Companies are no longer simply looking for workers to operate machinery. They need employees who can understand complex systems, troubleshoot problems, and work alongside advanced technologies.

The skills shortage is also creating operational challenges for manufacturers. Unfilled positions can lead to reduced production efficiency, increased overtime costs, longer training periods, and delays in expansion plans. In some cases, companies report turning down new business opportunities because they do not have sufficient personnel to support additional production capacity.

Recognising the seriousness of the issue, many plastics manufacturers are taking proactive steps to strengthen their talent pipelines. Apprenticeship programmes, partnerships with technical schools, internships, and workforce development initiatives are becoming increasingly common. Companies are also investing more heavily in employee training and reskilling programmes to help existing workers adapt to changing technologies and production methods.

Industry organisations believe that improving the perception of manufacturing careers will also be critical. Modern plastics manufacturing offers opportunities to work with advanced technologies, automation systems, sustainable materials, and innovative production processes. However, outdated views of factory work continue to discourage many potential candidates from considering careers in the sector.

Looking ahead, workforce development is expected to remain a top priority for plastics manufacturers worldwide. As demand for advanced manufacturing skills continues to grow, companies that successfully attract, train, and retain talent will be better positioned to compete in an increasingly complex and technology driven marketplace.

The message from industry leaders is clear. Investments in machinery and technology are important, but people remain the foundation of manufacturing success. Without a skilled workforce, even the most advanced production facilities will struggle to achieve their full potential.

SELF-HEALING POLYMERS MOVE FROM THE LAB TO THE REAL WORLD

Materials that can repair themselves are opening new possibilities for electric vehicles, aerospace, healthcare and smart electronics worldwide.

By Team ET Now Polymers

For decades, engineers have accepted one simple reality. Every material wears out. A scratch becomes a crack. A crack becomes damage. Damage eventually leads to repair or replacement.

Now, scientists are working on a solution that sounds almost futuristic. Polymers that can heal themselves.

Self-healing polymers are a new class of smart materials that can automatically repair small cracks, scratches and damage without human intervention. Inspired by the way human skin heals after a cut, these materials are being developed to make products safer, longer lasting and more sustainable.

What was once confined to research laboratories is now moving closer to commercial reality.

The opportunity is significant. According to industry estimates, the global self-healing polymers market was valued at about $3.8 billion in 2025 and is projected to reach **$18.4 billion by 2033,** growing at an annual rate of nearly 22 percent. The broader self-healing materials market is expected to touch $14.6 billion by 2033. Growth is being driven by demand from the automotive, electronics, healthcare and infrastructure sectors.

At the heart of the technology is a simple idea. When damage occurs, special chemical bonds within the polymer reconnect and repair the affected area. Some systems use tiny capsules filled with healing agents that are released when cracks form. Others rely on reversible molecular bonds that can rebuild themselves repeatedly. Researchers are also developing autonomous systems that can heal without external heat or pressure.

The **automotive sector** is emerging as one of the biggest adopters. Self-healing polymers can be used in protective coatings, vehicle interiors, battery casings and lightweight structural components. As electric vehicle production rises globally, manufacturers are looking for materials that can reduce maintenance costs and improve durability. Industry forecasts show automotive applications accounted for more than 32 percent of the self-healing polymer market in 2025.

The **aerospace industry** is equally interested. Aircraft components face constant stress, temperature changes and environmental exposure. Self-healing materials can help prevent microscopic damage from developing into larger structural problems. This could improve safety while reducing inspection and maintenance requirements. For an industry where reliability is critical and downtime is expensive, the benefits are hard to ignore.

Healthcare represents another promising frontier. Researchers are

developing self-healing polymers for wound care, implants, tissue engineering and drug delivery systems. Natural polysaccharides such as chitosan, alginate and cellulose are gaining attention because they are biocompatible and environmentally friendly. Recent studies suggest these materials could play an important role in next generation biomedical devices and regenerative medicine.

Flexible electronics is another area attracting investment. As wearable devices, sensors and foldable electronics become more common, manufacturers need materials that can survive repeated bending and stretching. Self-healing polymers can extend the lifespan of these products by repairing minor damage before it affects performance. Researchers are already exploring applications in energy storage devices, smart textiles and advanced sensors.

Beyond automobiles, healthcare and electronics, self-healing polymers are finding applications in infrastructure and industrial coatings. Bridges, pipelines, storage tanks and industrial equipment are constantly exposed to moisture, chemicals and mechanical stress. Even tiny cracks can eventually lead to corrosion, leakage and costly repairs. Self-healing coatings can automatically seal these micro cracks before they become major problems, helping extend the life of critical assets and reducing maintenance requirements.

Nanotechnology is also accelerating the development of self-healing materials. Researchers are incorporating nanoparticles, graphene and advanced fillers into polymer systems to improve strength, conductivity and healing efficiency. These materials not only repair themselves but can also retain high levels of mechanical performance after repeated damage. This is particularly important for sectors such as aerospace, advanced manufacturing and electric mobility where material reliability is essential.

Another emerging area is energy storage. Scientists are exploring self-healing polymers for batteries and supercapacitors where repeated charging and discharging can cause internal damage over time. By repairing microscopic defects, these materials could improve battery safety, extend operational life and enhance overall performance. As electric vehicle adoption accelerates worldwide, this application alone could become a major driver of future demand.

India is also entering the race. Researchers at **IIT Bhilai** recently developed a self-healing polymer that can repair itself at room temperature. The material is impact resistant, thermally stable and capable of regaining much of its original strength after damage. Potential applications include electric vehicles, aerospace structures and protective equipment. The development highlights the growing role of Indian research institutions in advanced materials science and their ability to contribute to globally relevant innovations.

The sustainability angle is equally compelling. Every year, industries spend billions replacing damaged materials and components. Self-healing polymers could extend product life, reduce material waste and lower carbon emissions associated with manufacturing replacements. At a time when companies are under increasing pressure to improve sustainability performance, these materials offer both environmental and economic advantages.

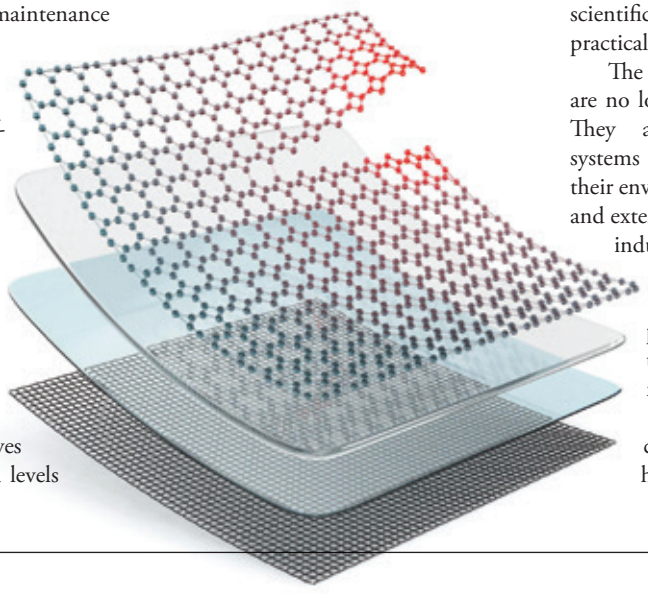
Perhaps the biggest attraction of self-healing polymers is their potential to lower lifecycle costs. Maintenance and replacement activities account for a significant share of operating expenses across industries. Materials that can automatically repair minor damage can reduce downtime, improve asset utilisation and enhance long term efficiency. This makes them attractive not only from a technical perspective but also from a business standpoint.

However, a few challenges still remian. Production costs are still high, large-scale manufacturing is limited, and long-term performance data is still being generated. Many technologies are in the early stages of commercialisation and will require further validation before widespread adoption becomes possible.

Amidst rapid advances in polymer chemistry, nanotechnology and material science are helping bridge these gaps. As research moves from laboratories to commercial applications, self-healing polymers are gradually evolving from a scientific breakthrough into a practical industrial solution.

The bigger story is that polymers are no longer just passive materials. They are becoming intelligent systems capable of responding to their environment, repairing damage and extending their own lifespan. As industries seek smarter, more durable and sustainable materials, self-healing polymers may well represent the next major leap in material innovation.

The age of materials that can repair themselves may have finally arrived.



FUTURE PROCESSORS START HERE

Equipping school students with plastics knowledge, recycling skills, and sustainability awareness can create the workforce needed for tomorrow's circular economy.

By Team ET Now Polymers

The plastics industry is changing rapidly. Today, the sector is no longer focused only on manufacturing products. It is increasingly driven by sustainability, recycling, automation, and circular economy practices. As industries adapt to these new realities, one challenge is becoming clear: where will the next generation of skilled plastics professionals come from?

The answer may begin much earlier than college or technical training. Secondary education programs have a critical role to play in preparing young people for careers in plastics processing, recycling, material science, and sustainable manufacturing.

The need for talent has never been greater. According to the **Plastics Industry Association,** demand for skilled workers such as engineers, technicians, machinery specialists, and production professionals is expected to grow steadily over the next decade. Engineers alone are projected to see employment growth of nearly **14 percent by 2033,** while industrial machinery maintenance roles could grow by more than **20 percent.** At the same time, manufacturers around the world are reporting difficulties in finding workers with the right technical skills.

This growing skills gap presents an opportunity for schools. By introducing plastics related learning at the secondary level, educators can help students understand both the science and the career opportunities behind one of the world's most important materials.

The importance of plastics education becomes even clearer when we look at global trends. Worldwide plastic production reached approximately **460 million tonnes in 2019,** double the level seen in 2000. Without significant intervention, global plastic consumption could exceed **1.2 billion tonnes** annually by **2060.** At the same time, plastic waste generation is expected to continue rising, creating an urgent need for better recycling systems and more circular solutions.

This is where young people can make a difference.

Modern plastics education is no longer about simply learning how products are made. It is about understanding materials, waste management, recycling technologies, product design, and environmental responsibility. Students can learn how plastics are sorted, processed, and converted into new products. They can explore how advanced technologies such as automation, artificial intelligence, and data analytics are improving recycling efficiency and manufacturing performance.

Schools can support this transition through practical learning

experiences. Recycling projects, laboratory demonstrations, design challenges, and partnerships with local industries can make plastics education more engaging and relevant. Students gain hands on experience while developing problem solving and critical thinking skills that employers increasingly value.

Beyond technical knowledge, plastics education helps students understand how manufacturing connects to everyday life. Plastics play an important role in healthcare, food packaging, transportation, electronics, and renewable energy. Learning about these applications allows students to see how innovation in materials and manufacturing can improve people's lives while addressing environmental challenges.

Project based learning can make these lessons even more meaningful. Students can be encouraged to design products using recycled materials, develop ideas to reduce packaging waste, or explore ways to improve recycling systems within their schools and communities. These activities promote creativity, teamwork, and innovation while reinforcing the importance of responsible resource use.

Industry engagement can further strengthen learning outcomes. Guest lectures from industry experts, factory visits, mentorship programs, and internships provide students with valuable exposure to real world workplaces. Such experiences help bridge the gap between education and employment, giving young people a clearer understanding of career opportunities in engineering, recycling, product design, and advanced manufacturing. They also help companies connect with future talent and build a stronger workforce pipeline.

The focus on sustainability is particularly important. According to the **OECD,** only about **9 percent** of plastic waste was recycled globally in **2019,** highlighting the need for innovation and better resource management. While production of recycled plastics has grown significantly over the past two decades, recycled materials still represent only a small share of total plastic production. This means there is enormous potential for future improvement and career opportunities in recycling and circular economy solutions.

Industry led education initiatives are already demonstrating what is possible. Training centres and technical institutes are offering programs in waste management, recycling technologies, sustainability, product design, and advanced manufacturing. These programs help bridge the gap between classroom learning and real world industry requirements.

Another important reason to start plastics education early is awareness. Young people are increasingly concerned about environmental issues. By teaching students about responsible plastics use, material innovation, and recycling systems, schools can replace misconceptions with knowledge and empower future consumers, innovators, and policymakers.

The future plastics workforce will look very different from the one that built the industry decades ago. Tomorrow's processors will need digital skills, sustainability expertise, and a strong understanding of circular manufacturing. They will be expected to create products that use fewer resources, generate less waste, and remain in circulation for longer.

Secondary education programs can become the foundation for this transformation. By exposing students to plastics science, recycling technologies, and sustainable manufacturing practices at an early stage, schools can inspire future engineers, recyclers, designers, and entrepreneurs.

The plastics industry of tomorrow will depend not only on new technologies but also on new talent. Investing in secondary education today is one of the most effective ways to ensure that the next generation of processors is ready to build a smarter, cleaner, and more sustainable future.

THE PACKAGING WAKE UP CALL

Europe's new packaging rules are set to reshape global supply chains, forcing Indian manufacturers to rethink design, recycling, and compliance.

By Team ET Now Polymers

The **European Union's Packaging and Packaging Waste Regulation, better known as PPWR,** is being described as one of the most significant packaging laws introduced anywhere in the world in recent years. While the regulation is European, its impact will be felt far beyond the continent, including in India. Companies that export packaging, packaged products, films, labels, and consumer goods to Europe will all be affected.

The regulation officially entered into force in February 2025 and will begin applying from August 2026. Unlike previous directives that allowed countries to create their own rules, PPWR creates a common framework across all European Union member states. Its goal is simple: reduce packaging waste, improve recyclability, increase the use of recycled content, and accelerate the shift towards a circular economy.

The urgency behind the regulation is easy to understand. According to the European Commission, packaging waste in the EU exceeded 84 million tonnes in 2021, with each citizen generating nearly 190 kilograms of packaging waste annually. Without intervention, packaging waste was projected to continue rising sharply over the coming years. Plastic packaging remains one of the biggest concerns because of its widespread use and the challenges associated with collection and recycling. PPWR is therefore designed not only to reduce waste but also to ensure that packaging materials remain in circulation for longer.

At first glance, PPWR may appear to be just another environmental regulation. In reality, it represents a fundamental shift in how packaging is designed, manufactured, used, collected, and recycled.

One of the biggest changes is that all packaging placed on the European market will need to be designed for recycling. The days of complex packaging structures that are difficult to recycle are slowly coming to an end. Companies will increasingly be

expected to use packaging that can be collected, sorted, and recycled at scale. The regulation also introduces recyclability performance grades and stricter requirements over time.

The regulation also promotes greater use of recycled content in plastic packaging. Over the coming years, packaging producers will need to demonstrate that recycled materials are being incorporated into their products. In addition, there are new requirements related to packaging reduction, reuse systems, labelling, and extended producer responsibility.

For Indian industry, this is not just a European issue.

India is one of the world's largest producers of flexible packaging, films, labels, laminates, and packaging materials. Companies across the country export packaging products directly to Europe or supply multinational brands that sell into European markets. For these businesses, PPWR will effectively become a business requirement rather than just a regulatory requirement.

The stakes are significant. India's packaging industry is estimated to be worth more than **USD 75 billion** and is growing at one of the fastest rates globally. Flexible packaging accounts for a substantial share of this market, with Indian manufacturers supplying products to customers across Europe, North America, the Middle East, and Asia. Any regulatory change in a major export market such as the EU therefore has the potential to influence investment decisions, product development strategies, and future capacity expansion plans.

Indian film manufacturers, converters, recyclers, and packaging suppliers may need to review their product portfolios to ensure compliance with future recyclability standards. Multi material structures that have traditionally delivered performance benefits could come under increased scrutiny if they are difficult to recycle. This is likely to accelerate investment in mono material solutions and packaging formats that support easier recycling.

The regulation could also create fresh opportunities for Indian manufacturers.

As global brands search for packaging partners capable of meeting stricter sustainability requirements, companies that invest early in recyclable structures, recycled content, traceability, and compliance systems could gain a competitive advantage. Sustainability is increasingly becoming a market differentiator rather than just a compliance exercise.

The recycling sector could also benefit. Demand for high quality recycled plastics is expected to grow as packaging producers work to meet recycled content requirements. This may encourage additional investment in collection, sorting, recycling, and material recovery infrastructure, both in Europe and across global supply chains. Industry estimates suggest that global demand for recycled polymers could increase significantly over the next decade as governments and brand owners pursue ambitious sustainability targets.

There will, however, be challenges.

Compliance will require greater documentation, testing, certification, and data management. Companies will need to understand not only the composition of their packaging but also how it performs at the end of its life. Many businesses may need to strengthen collaboration across their supply chains to ensure traceability and regulatory compliance. Recent guidance from the European Commission has also highlighted growing attention on labelling requirements, digital information systems, recyclability assessments, and extended producer responsibility obligations.

For many Indian companies, the most important lesson is that PPWR is not a future issue. It is already influencing packaging decisions, material selection, and procurement strategies among global brands. Companies that wait until compliance deadlines arrive may find themselves playing catch up.

The packaging industry has always evolved in response to changing consumer needs, technology, and regulation. PPWR is likely to become another defining moment in that journey. While the regulation originates in Europe, its influence will be global. For Indian manufacturers, converters, recyclers, and brand owners, the message is clear: the future of packaging will be more recyclable, more circular, and more accountable than ever before.

Those who adapt early will be best positioned to benefit from the opportunities that lie ahead.

INDIA REINVENTS PLASTICS WITH BAMBOO

India is blending traditional natural materials with advanced polymer science to build sustainable high-performance materials for the future.

By Team ET Now Polymers

For decades, the plastics story has been written around oil, gas and petrochemicals. But a quieter shift is now taking place in India. Scientists, engineers and startups are turning to something far more familiar and abundant. Bamboo, agricultural waste and natural fibres.

This is not nostalgia. It is material science.

Across research labs and industrial pilot projects, India is building a new class of composites that combine natural resources with modern polymers. The result is a growing movement that could reshape how plastics are made, used and replaced.

At the centre of this shift is work from the **Indian Institute of Technology** Guwahati, which has emerged as one of the key research hubs in natural fibre-based composites.

Researchers at the institute have developed bamboo reinforced polymer composites that are designed specifically for automotive interiors and structural applications. The material uses **Bambusa tulda,** a fast-growing bamboo species widely available in Northeast India, combined with polymer matrices such as epoxy systems.

The result is a lightweight and mechanically strong composite that shows tensile strength of up to around **145 megapascals** and thermal stability above **110 degrees Celsius** in controlled laboratory conditions. These properties make it suitable for automotive applications such as interior panels, dashboards, door trims and seat back structures.

In simple terms, it means bamboo is no longer just a building material in rural areas. It is becoming a potential replacement for plastic components inside vehicles.

The importance of this innovation goes beyond performance. India is one of the largest producers of bamboo globally, but industrial utilization remains limited. A large portion of this natural resource is still underused despite its rapid growth cycle and renewability.

By converting bamboo into engineered composites, researchers are attempting to bridge this gap between natural abundance and industrial demand.

But bamboo is only one part of a much larger shift.

Across India, agricultural residues such as coir, rice husk, bagasse and jute are being transformed into reinforcement materials for polymer systems. These fibres are being blended with thermoplastics and thermosets to produce composites that are lighter, cost effective and more sustainable in selected applications.

The appeal is straightforward. These materials convert agricultural waste into value added industrial inputs instead of allowing it to be burned or discarded. In a country that generates millions of tonnes of agricultural residue every year, this represents a significant untapped resource base.

Alongside natural fibre composites, another important innovation stream is emerging in bio-based epoxy systems.

Traditional epoxy resins used in coatings and composites are derived from petroleum chemistry and are associated with high carbon intensity. Researchers are now developing bio epoxy alternatives using plant oils, lignin and other renewable feedstocks.

These bio-based resins are being tested in adhesives, protective coatings and structural applications. While they are still more expensive than conventional systems, they offer the possibility of reducing dependency on fossil derived raw materials.

What makes these developments important is not just their environmental value but their industrial relevance.

India produces large volumes of agricultural waste and has one of the largest bamboo reserves in the world. If even a fraction of this material can be converted into industrial grade composites, it could create a parallel raw material ecosystem alongside petrochemicals.

Startups are also entering this space with increasing interest.

Several young companies are working on bioplastics, natural fibre composites and hybrid materials that combine recycled polymers with agricultural fibres. Applications range from packaging and consumer goods to automotive components and construction materials.

While many of these solutions are still in early commercial stages, they are beginning to attract attention from global brands that are under pressure to reduce carbon emissions across their supply chains.

One of the key drivers behind this movement is the global shift toward sustainability and regulatory compliance. Automotive companies, packaging manufacturers and construction firms are increasingly required to disclose lifecycle emissions, improve recyclability and reduce virgin plastic usage.

Natural fiber reinforced polymers offer a partial solution, especially in non-critical structural and interior applications where extreme performance requirements are lower.

However, the shift is not simply about replacing plastics. It is about redesigning materials from the ground up.

Researchers are increasingly focusing on hybrid composites where bamboo fibres are chemically treated to improve adhesion and then integrated into polymer matrices for better durability and consistency. Advanced manufacturing processes

such as compression molding and resin transfer molding are helping scale these materials from laboratory prototypes to industrial applications.

There is also growing experimentation with hybrid systems that combine recycled plastics with natural fibres. This approach improves waste utilization while reducing dependence on virgin petrochemicals, creating a more circular material flow.

Despite strong progress, challenges remain significant.

Natural fibre composites often face variability in quality due to differences in raw material sourcing and processing conditions. Moisture sensitivity and long-term durability are also key engineering concerns that need further research. Bio epoxy systems, while promising, remain relatively expensive compared to conventional petrochemical based alternatives.

Yet the direction of travel is becoming increasingly clear.

India is gradually building a parallel materials ecosystem where forests, farms and factories are becoming interconnected parts of the same industrial value chain.

Globally, biomaterials are expected to play an increasingly important role in the transition toward low carbon manufacturing. Automotive, construction and packaging sectors are expected to be early adopters due to their large material consumption and rising sustainability commitments.

India's advantage lies in its raw material base and strong academic research ecosystem. Institutions such as **IITs** and **CSIR** laboratories are actively developing indigenous solutions, while startups are exploring ways to commercialize them at scale.

The deeper transformation is philosophical as well as technological.

Nature is no longer being viewed only as a source of raw consumption. It is increasingly being seen as a source of engineered materials. Bamboo is becoming a structural component. Agricultural waste is becoming feedstock. Biomass is becoming industry input.

If this transition scales successfully, the future of plastics in India will not be defined by a single material system.

It will be a hybrid world where petrochemical polymers, recycled plastics and natural fibre composites coexist.

A future where the next generation of materials is not only manufactured in refineries but also grown in fields and forests.

SMART PACKAGING FOR A SUSTAINABLE FUTURE

As food and pharma packaging evolve towards sustainability, intelligent automation is enabling manufacturers to achieve greater precision, efficiency, and reliability.

By Mr Anil Kumar, Managing Director, Inovance Technology India

The food and pharmaceutical packaging industries are undergoing a significant transformation driven by sustainability goals, stricter regulatory requirements, and growing demand for product safety. As manufacturers adopt recyclable materials and advanced packaging formats, the need for intelligent technologies that ensure precision, efficiency, and reliability has become increasingly important. Through advanced **Plastic Injection Molding Machine (PIMM) and Full Electric Injection Molding Machine (FIMM) solutions, Inovance Technology** is helping packaging manufacturers improve productivity, quality, and sustainability.

Sustainable Materials and High-Barrier Packaging

Packaging plays a critical role in preserving product integrity, particularly in food and pharmaceutical applications where protection against moisture, oxygen, and contaminants is essential. High-barrier materials are increasingly being adopted to extend shelf life and maintain product efficacy. At the same time, sustainability initiatives are accelerating the shift towards recyclable multilayer structures and mono-material packaging solutions.

Processing these advanced materials requires highly accurate and repeatable manufacturing processes. Intelligent automation and motion control technologies help manufacturers maintain consistency, minimise material wastage, and optimise energy consumption, thus enabling businesses to meet sustainability objectives.

Anil Kumar, Managing Director, Inovance India

Meeting Compliance Through Intelligent Manufacturing

Food and pharmaceutical packaging manufacturers operate in a highly regulated environment where quality, traceability, and process reliability are non-negotiable. As regulations continue to evolve, manufacturers need production systems capable of maintaining tight tolerances and delivering consistent results.

Advanced Injection Molding Solutions

The growing popularity of flexible packaging formats such as pouches and sachets is growing rapidly. Hence, packaging machinery must deliver precise control, rapid response, and high repeatability to support these requirements.

Inovance's PIMM solutions address these challenges through technologies such as the **ES680 electro-hydraulic** servo drive and **IS580 hydraulic** servo drive, delivering precise control result in faster dynamic response, and significant energy savings.

Complementing these are the MEG20/23 series motors and ISMG servo motors, which provide stable performance, high efficiency, and accurate motion control, helping manufacturers improve product quality while reducing operating costs.

Enabling the Next Generation of Packaging

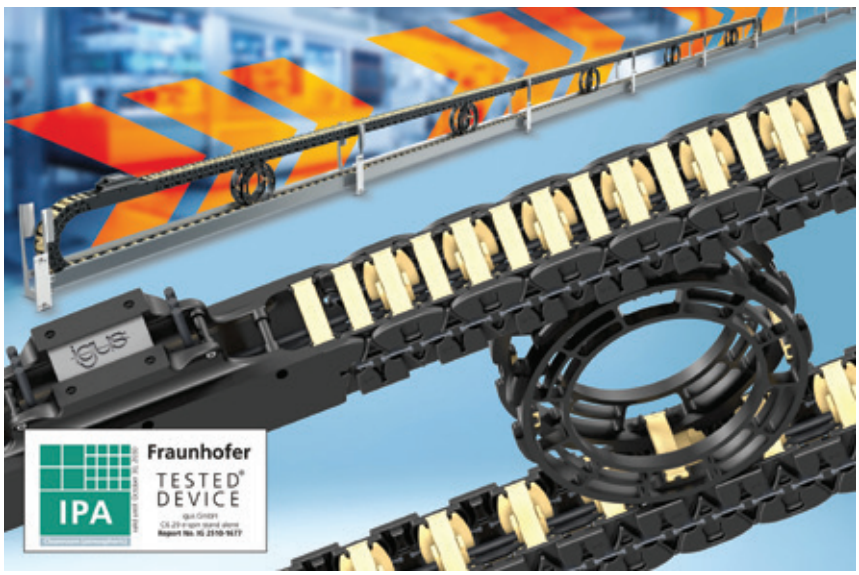
The industry's future will be shaped by sustainable materials, recyclable packaging structures, regulatory compliance, and intelligent manufacturing. Inovance's FIMM solutions, featuring MEG series servo motors, HSP and HSL ball screws, and EFYH ring force transducers, enable higher precision, lower energy consumption, and improved process repeatability. Thus, by integrating advanced automation, motion control, and injection molding technologies, manufacturers can enhance product quality, reduce environmental impact, and remain competitive in an increasingly demanding market.

Cleanroom Energy Supply for Long Travels

igus introduces an ISO Class 1-certified energy supply solution that enables reliable, low-abrasion power and data transmission over cleanroom travel distances of up to 30 metres.

By Team ET Now Polymers

As industries such as microelectronics, semiconductor manufacturing, and battery production continue to expand and automate, maintaining contamination-free environments while ensuring reliable system performance has become increasingly critical. At the same time, growing production facilities and longer material transport routes are creating new challenges in supplying power and data within cleanroom environments. Addressing these demands, igus has introduced its C6 cleanroom energy chain in combination with the new e-spin upper run guide system, offering a compact, durable, and abrasion-resistant energy supply solution for travel distances of up to 30 metres. The system has been awarded ISO Class 1 certification by the Fraunhofer IPA, confirming its suitability for the most demanding cleanroom applications.



The C6 energy chain in combination with the new e-spin upper run guide wheel allows for reliable energy and data supply with minimal particle emissions - on travels of up to 30 metres. *(Source: igus SE & Co. KG)*

Modern semiconductor manufacturing involves numerous highly sensitive process steps, including lithography, etching, and metallisation. Throughout these stages, silicon wafers must be transported efficiently while maintaining strict cleanliness standards. As manual transport within cleanrooms is not practical, manufacturers increasingly rely on automated systems to move wafer cassettes safely over long distances. One widely adopted solution is the overhead hoist transport (OHT) system, a ceiling-mounted rail network that maximises cleanroom space utilisation while supporting automated material handling.

However, supplying OHT systems with both power and data remains a significant engineering challenge. Conventional busbar systems are unable to transmit data and often require considerable maintenance. Traditional energy chains, meanwhile, typically need complex extraction systems to manage microparticle emissions. According to **Kira Weller, Product Manager** for e-chains and Cleanroom Expert at igus, the industry has long sought a cleanroom-compatible, durable, and cost-effective alternative capable of addressing these limitations.

To meet this requirement, igus developed the e-spin guide system specifically for use with the C6 cleanroom energy chain. The innovative design incorporates guide wheels manufactured from tribologically optimised high-performance plastic engineered to minimise friction and wear. Positioned between the upper and lower runs of the energy chain, these guide wheels allow the chain segments to roll rather than glide against one another. As a result, the energy chain system can be deployed in cleanroom production environments without the need for dedicated particle extraction units.

Constructed from high-performance plastic, the combined C6 energy chain and e-spin guide wheel system delivers excellent abrasion resistance, low maintenance requirements, and long service life. Independent laboratory testing conducted in collaboration with the Fraunhofer IPA confirmed that the solution achieves the highest cleanroom classification, ISO Class 1, at an operating speed of 0.5 m/s, making it a reliable choice for next-generation cleanroom automation systems.

Food industry

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