

Molecular Foundations

The Great Inflection of a Material World

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The global chemicals sector wields \$5.7 trillion in worldwide economic impact, the European Chemical Industry Council reported at the top of this year. Diverse players all along the value chain have adapted to ongoing market fluctuations, geopolitical conflicts and safety, environmental and trade regulations that are increasing, changing or tightening. Urgent material demands for everything from commodities to the cutting-edge computer chips they help build are pushing companies to pivot, optimize, cooperate and invent with their human experience and the power of artificial intelligence. These adjustments represent a major evolutionary stage for the sector.

Unpredictability has been the most enduring constant over the last year. “Global volatility will become the new normal,” forecasted Sangwoo Ryu, CEO of Kraton Corporation. Born from Shell and based in Texas, the global supplier of pine chemicals and flexible industrial polymers is leveraging highest quality market data with the newest digital and AI models.

To navigate and adapt to shifting market conditions, corporate leaders are recalibrating how they source, optimize, process and scale metals, molecules and mixtures that power human progress. This navigation of and adaptation to shifting supply chain and market conditions is elemental.



The distributor's role has evolved from moving products - to accelerating growth for principals and customers by creating value and resilience across the entire value chain.

DERK JAN TERHORST | CEO,
BARENTZ



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“Every product in the modern world now needs rare earths, precious metals or technology metals,” said Matthias R  th, the founder and CEO of Tradium, an international intermediary and supplier of metals for the technology and manufacturing sectors. “What AI will do is increase demand for these materials because of new electronic and computing applications that require these raw materials.”

These needs are prompting the discovery of new materials, trade paths, relationships and ways to optimize resources including waste. They are also resetting the bases of economic competition.

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Indium Corporation is expanding to meet global demand, investing in factories, equipment, automation, and engineering talent around the world. This approach strengthens customer service while building a more resilient, sustainable materials supply chain.

**ROSS BERNTSON |
PRESIDENT AND CEO,
INDIUM CORPORATION**



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Rüth said China applies export controls to the most needed metals and raw materials, inflating prices to 10 to 20 times what they would be otherwise. “Across the market, supply remains limited, regardless of what customers are willing to pay,” he added, urging industrial buyers to stockpile materials.

The rapidly growing areas of energy storage, technological infrastructure and advanced manufacturing of semiconductors, robotics and mobility solutions are feeling the pain of higher costs and scarcity acutely. This is so much the case that in July, the United States declared certain strategic materials a matter of American national security by executive order, devoting funding and incentives to match.

These materials serve mission-critical applications—something Brad Bolduc, CEO of Arclin, knows a lot about. “As a global materials science provider, we tailor molecules, formulations and polymers to address unmet needs and real pain points across our customers’ markets,” he said, hot off a \$1.8 billion acquisition of DuPont’s Aramids business and the Nomex® and Kevlar® brands earlier this year.

Just 10 years ago, Arclin’s portfolio was 75 to 80 percent weighted toward building products for housing-related markets. The company continues innovating protective home elements while rapidly moving into data centers, electrical infrastructure, agriculture, defense, pharmaceuticals and an aerospace maintenance backlog dating back to the pandemic.

While consolidation and onshoring in response to supply chain bottlenecks might normally signal protectionism and decline, Giovanni Corder, director of the European Semiconductor Industry Association (ESIA), made a distinction. “What we see is de-risking, not decoupling, with more companies serving local markets. Companies are operating globally but trying to focus on serving local markets to avoid supply chain risks,” he explained.

Moreover, companies are determined to find opportunities from uncertainty, scarcity and cost pressures. “Growth is going to come more from value, launching new products, partnering on innovation and solving customer problems rather than simply selling more volume,” said Scott Richardson, CEO of Dallas materials and chemicals company Celanese. “Through logistics centers close to

customers, we can provide efficient, just-in-time delivery with the right quantity and formulation,” said Emmanuel Ligner, president and CEO of Avantor.

“Simplifying supply chains and bringing that one product to customers on a just-in-time basis creates a lot of efficiencies and value for them and for us,” said CEO Bob Craycraft of Univar Solutions. The stalwart distributor, which has met global needs for a century, blends specialty chemicals on site to save customers steps and money. Univar also transitions AI centers from water to glycol cooling solutions and finds value-saving circularities in clients’ waste streams.

The need to submerge entire data centers in chemical coolants is a testament to their higher computing density. As more systems and individuals rely on increasingly powerful digital and AI solutions, demand is spiking for one thing above all: more energy.

Powering the AI surge

As data centers proliferate to upgrade the foundation for modern computing, the demand for power to build and run them far outstrips supply. “Our country’s industrial storage is about 98% full. Electrical capacity and water systems are also operating at their limits,” said Ramón Isla, CEO of FR Terminales.



**STEVE COTTON | PRESIDENT & CEO,
AQUA METALS (NASDAQ: AQMS)**

The Commerce Department’s new rule will keep black mass, battery material rich in critical minerals, in America. The next bottleneck and value creation opportunity is domestic refining. Aqua Metals has demonstrated the technology to close that gap.



REBECCA LIEBERT | CEO, LUBRIZOL

Formulating locally drives the supply chain and production needed in the region for support. We also have a business continuity plan for how to move our sourcing around to always meet our customers’ needs when there are disruptions.



**NATALE CAPRI | GLOBAL HEAD,
PERFORMANCE MATERIALS, DKSH**

Customers no longer look only for someone who just delivers goods. They need partners in navigating supply chain complexity, accelerated innovation cycles, regulatory requirements, sustainability expectations and the early identification of changing consumer trends.



**JIM HOLCOMB | CEO,
EMCO CHEMICAL DISTRIBUTORS**

Chemistry can have negative connotations to laypeople but the premise of modern life deeply depends on chemicals.

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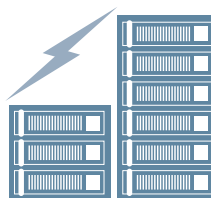


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▶ The result is next-generation energy innovation. Google is waiting for Kairos Power, built in a World War II Alameda Naval Air Station across the Bay from the University of California, Berkeley, the cradle of nuclear science and technology where co-founder and CEO Dr. Mike Laufer began developing the company.

“Our original plan was to demonstrate the technology this decade and prepare to scale in the 2030s. Demand has accelerated, and the question is now how much clean, reliable power we can deliver, and how quickly,” said Laufer. When Kairos reactors go online in Oak Ridge, Tennessee, they will use Flibe molten fluoride salt coolants instead of water and high-pressured steam to generate energy from TRISO uranium pebbles. While nuclear generators involve atomic-level physical, not chemical, reactions, Laufer said chemical control and testing minimize surprises and support economical operation.

Nearly five decades into her career navigating the global petrochemicals market, Gina Fyffe, founder and CEO of Integra Petrochemicals, believes that chemicals derived from crude oil will continue to be needed as the energy transition drives forward. “People may reduce chemicals to being good or bad, but modern life would look completely different without them and we will probably need them for another half-century of transition,” estimated Fyffe. “The materials themselves are only part of the story—we must make, use and dispose of them far more responsibly.” Justin Disney, director of Laboratory and R&D Services at Jacam Catalyst, agreed. “The oil industry still has a



Data center electricity usage will double by 2030

AI's share will go from 20% to 40%

Source: United Nations University Institute for Water, Environment and Health (UNU-INWEH) June, 2026

long runway left. We all want a cleaner environment with renewable energy, but our lives are still built around hydrocarbons,” he said.

Because the need for resources does not subside in the face of volatility, CEO Ofek Levy of Valor International devises formulations to optimize oilfield operations. Despite geopolitical challenges, Valor’s expansions in the Middle East portend market growth into the tens of millions of dollars by year’s end.

“With disruptions around the Strait of Hormuz constricting global supplies and contributing to volatility in key chemical feedstocks and industrial raw materials, we had to adapt quickly,” recalled Levy. The company had to pivot quickly as a response to the geopolitical situation, “rather than remain dependent on traditional distillate-based formulations, we shifted toward brine-based suspension systems that are free of distillates and sheening and can meet demanding performance and environmental requirements,” he said.



GINA FYFFE | FOUNDER & CEO, INTEGRA PETROCHEMICALS

In volatility, optionality is often more valuable than the lowest possible price. In 40+ years working through various geopolitical, pandemic and climate crises, I’ve learned: if you wait until day one of a crisis to prepare you’re already too late.



STEPHEN ELLIOTT | CHIEF EXECUTIVE, CHEMICAL INDUSTRIES ASSOCIATION (CIA)

The economy needs a sound manufacturing base and secure chemical underpinnings. Energy can account for more than half of the chemical industry’s costs and remains the biggest constraint to competitiveness.



JONATHAN EVANS | PRESIDENT & CEO, LITHIUM AMERICAS

Lithium is an energy security story. Our industry still relies heavily on physical processes. We are one of the industries you cannot AI. Grow it or dig it – data centers are not going to be possible without people like us.



RICK LUEBBE | CEO, GROUP14 TECHNOLOGIES

While the current administration retracts wind and solar initiatives, it is prioritizing critical materials and batteries because of their importance from both an economic and national security perspective.

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**NITIN GUPTA | CO-FOUNDER & CEO, ATTERO**

The energy transition is entirely premised on storage technology. More than \$200 billion has been deployed globally into the lithium-ion battery ecosystem in recent years and there is an exponential amount of secondary materials available from this.

**DAVID KLANECKY | PRESIDENT & CEO, CIRBA SOLUTIONS**

Energy storage systems and AI data centers are growing at exponential rates, many of which are being powered by batteries. This is increasing the demand for critical minerals needed to manufacture new batteries.

**MAXIME TRÈVE | CEO, BATTRI**

Change needs to happen through competitiveness. A massive amount of money is required to refine competitively at an industrial scale. Establishing operations without subsidies like the ones in Asia is making it very hard for Americans and Europeans to compete.

**TYLER HORTIN | PRESIDENT & CEO, LION ENERGY**

We are at the beginning of an energy boom in the U.S. – most people do not realize how big and powerful this transition is going to be, and that it has been a long time coming.

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“Most of the technology and materials are in the hands of China,” asserted Ilka von Dalwigk, general director of RECHARGE, the European Association of the Advanced Rechargeable and Lithium Batteries Value Chain. “To close cost gaps with Asia, Europe must see that we need public money to be oriented to output, supporting the ramp-up of manufacturing projects,” she said, of what it would take for the region’s renewable battery companies and broader manufacturing industries to compete globally.

“As market constraints have developed, germanium and gallium prices have become extraordinarily high, reinforcing the importance of building a more resilient supply chain,” said Ross Berntson, president and CEO of Indium Corporation. Though the namesake of the operations, indium, is the ductile, malleable metal of choice for the semiconductor and aerospace industries, gallium is tracking for higher value because of the heat resistance afforded by the metal’s thermal properties.

“Critical minerals are just rocks without chemistry,” reminded Greg Moffatt, CEO of the Chemistry Industry Association of Canada (CIAC). Another crisis beyond geopolitical conflict and scarcity of materials for certain regions, particularly the U.S. and Europe, is the struggle to competitively refine metals, chemicals and minerals to the quality and purity required by advanced, booming industries.

The European Union is discussing its Chips Act 2.0 ensuring previous investments in manufacturing and research and development succeed. Giovanni Corder, director of the European Semiconductor Industry Association (ESIA), beseeched the government to streamline factory permitting processes for European semiconductor companies ready to commercialize their marketable ideas from world-renowned research and development.

Some businesses are embracing the dominance and aggressive progression of China. “China is one of the world’s largest and fastest-growing chemical markets, and success there depends on being on the ground with the customers who rely on us,” said Charlie Shaver, chairman and CEO of Nouryon, which opened an innovation center

in Shanghai last year to deepen local co-development and support sustainable growth across China and the wider Asia-Pacific region.

Either way, semiconductor and advanced manufacturing sectors outside China want to engage with—or become—midstream players. Securing this technical capability helps them process valuable materials for use without the bottlenecking and vulnerability to price manipulation and supply dependency that comes from relying on one source. For now, this expertise is largely held in Asia, where the U.S. exported waste until revelations about the value and data security issues inherent to this stream.

At the crux of these challenges are batteries—storage for the energy whose demand is being outstripped by AI infrastructure and advanced industries manufacturing everything from biopharmaceuticals to spaceships.

Securing lithium is an industrial imperative. ReElement Technologies uses a proven process called chromatography in a modular, deployable system that refines metals with reusable resins rather than consumable solvents to recover and refine multiple metals from virgin ore and secondary feedstocks. Lithium Americas has support from the U.S. for the Thacker Pass Project in Nevada, slated to serve refined lithium to primary offtakers and joint venture partner General Motors and make domestic sources of lithium available to the likes of LG and Tesla.

Standard Lithium is planning to perform directional drilling and direct lithium extraction from pads of plentiful brine stretched over parts of Arkansas and Texas. Steve Cotton, president and CEO of Aqua Metals, is using electro-hydrometallurgy to recycle batteries for lithium iron phosphate (LFP) chemistries whose markets will increase 15-fold by 2030. The scramble for energy is also leading to a bloom of different chemistries. With support from the U.S. Department of Energy, Sila Nanotechnologies is expanding production of its Titan Silicon drop-in replacements for graphite anodes. Rick Luebke, CEO of Group14 Technologies, which has devised its own nanoscale scaffolding to tame silicon’s swelling properties, said “the new anodes have yielded battery charging speeds as fast as 90 seconds.”





As Mexico's industrial base grows, specialized logistics infrastructure is vital for new investment. FR Terminales is expanding across Mexico, delivering safe, reliable, and efficient logistics solutions to global chemical companies.

RAMÓN ISLA | CEO, FR TERMINALES



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“Finely engineered and improved components such as specific additives are primarily U.S. technology requiring protection,” said Luebbe. The company is tough on defending intellectual property, recognizing the implications to U.S. competitiveness. Otherwise, Luebbe said, the only real competition is the graphite anodes silicon technologies are rushing to replace.

“We are excited about helping people take advantage of energy. Batteries do not need to cost money. Over time, they should make you money by storing energy when it is cheap so you can use

it when it is expensive,” insisted Tyler Hortin, president and CEO of Lion Energy in American Fork, Utah. The company supports domestic production while catering to everyday end users with home and industrial LFP generators that empower customers to understand when the grid is giving away or even paying people to take energy and when it is aggregating savings for itself with peak pricing.

While electrified mobility drives the renewable batteries market, Lynn Calder, CEO of London-headquartered INEOS Automotive, said she was never of the opinion that 100 percent of people will one day all drive pure battery electric vehicles (BEVs). “The infrastructure is not there yet—it is too big of a sell. There have to be different options for different use cases,” said the executive. Her company’s answer to global materials and energy scarcity has been to launch the Grenadier and Fusilier vehicle lines of durable 4x4s that run, respectively, on conventional fuel and battery with a fuel-operated range extender to relieve range anxiety on long trips and remote missions.

Calder called the vehicles the opposite of fast fashion. “The Grenadier is a great way to remember that we need material things that last,” she said. Sixty-five percent of the European-produced Grenadier’s sales have been in the U.S.—heartening in the wild, wild Western market for EVs. “Stability is good but there is always opportunity in flux,” she said.

EYE ON ASIA-PACIFIC



ROBERT KANG | CO-FOUNDER, BLUE WHALE MATERIALS

Three of the four largest lithium-ion battery makers with United States operations are Korean companies. South Korean companies will be essential to reducing U.S. dependence on China’s grip on global supply chains.



DERK JAN TERHORST | CEO, BARENTZ

Australia and New Zealand are key growth markets for Barentz and an important part of our broader Asia-Pacific strategy. The expansion is also part of the broader presence we have been building in Asia, a huge area of growth that is home to half the world’s population.



NATALE CAPRI | GLOBAL HEAD, PERFORMANCE MATERIALS, DKSH

Asia-Pacific is our home market and growth engine. We have been there for over 160 years and are considered local there. These historical relationships, market insights and execution capabilities are unique and difficult to replicate.



AARON MONTGOMERY | CEO, OURAY ENVIRONMENTAL SERVICES

Across the region we see significant opportunity in chemicals, and especially in the shipment of bulk liquid and gas chemicals in ISO tanks, since there is little rail connectivity between these large industrial bases.

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Urban mining and circularity

The convergence of critical material scarcity with ever-increasing post-consumer waste is vaulting advanced recycling technologies toward commercialization after building patiently for years. Recycling technology can now dependably retrieve valuable materials at higher recovery and purity rates than ever before, closing the loop on circular economies and recruiting support from a broader base, including those who might have politically eschewed green technology and chemistry before. Now, infrastructure just has to catch up.

Black mass is the new gold. The eyeshadow-fine powder contains lithium, cobalt, nickel, graphite, manganese, iron and phosphate recovered from end-of-life batteries and factory scraps. Blue Whale Materials, which optimizes the synergy between U.S. and highly sophisticated Korean ecosystems, successfully deployed its first commercial battery recycling facility in Bartlesville, Okla., late last year, operating at a 98 percent recovery rate of critical materials. In a continuing partnership with the U.S. DOE, the company is expanding production of its proprietary black mass from 14,000 metric tons a year to 50,000.

“That sounds like a lot, but it is a drop in the bucket compared to the avalanche of spent batteries headed our way,” said co-founder Robert Kang, who is intent on strengthening the infrastructure for electronic waste collection, or what he calls urban mining.

Tesla alum Ryan Melsert, CEO of the American Battery Technology Company (ABTC), supported by over \$200 million in competitive grants from the U.S. DOE, tackles large mining, recycling and mitigation projects that others cannot. After jumping through multiple regulatory hoops, ABTC is getting closer to opening Tonopah Flats, a lithium mining and refining site in Nevada to support the stationary grid-scale battery market whose growth in the U.S. is outpacing EV demand. He credited the company’s right-sizing as the secret to survival and success when other businesses banking on EV growth were unable to maintain. “We sized our plant for where the industry actually is, not where we were hoping it would eventually go,” said Melsert.

India has become another hot spot for metals recovery because of advancements and improving quality of life. Attero, a recycler, has signed several billion-dollar contracts with OEMs for the offtake of copper, aluminum, cobalt, lithium carbonate and various other critical minerals. Co-founder and CEO Nitin Gupta described the human impact of having AI determine fair pricing for feedstock sources. Cutting out middleman aggregators helps give a fair price to vulnerable people collecting scraps for a pittance. “Women and



We are providing the reliability that delivers, in service, safety, and expertise. Industrial businesses have been under pressure and many have gone to just-in-time inventory needs. Fulfilling promises while under stringent requirements is increasingly critical, and the distributors able to do this make a difference.

BOB CRAYCRAFT | CEO, CD&S, UNIVAR SOLUTIONS



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children in this informal, illegal industry in India typically have a short life span,” Gupta said. Attero is cutting out that middleman while producing more value for the region.

PureCycle Technologies focuses on recycling plastic—the most used, least recycled No. 5 polypropylene, to be exact. “Two hundred billion pounds of brand new polypropylene is made every year. Probably less than 5% of this is recycled but the percentage is growing at 3% to 4% a year – six to eight billion pounds of recovered materials,” shared CEO Dustin Olson. PureCycle’s patented “molecular washing” technology converts used plastic into resin pure enough for carpet fibers, fine plastic film and lighter EV parts with less odor than virgin plastic. Olson is excited to “copy and paste” this technology and expressed the wish for more midstream processors with the ability to increase the volume of usable feedstock.

All around the world, advanced recyclers are devising optimized processes and investing in the physical infrastructure to capitalize on the value of waste. Jodie Morgan, CEO of advanced plastics recycler

EYE ON AMERICAS & MEXICO



CARLOS RIVAS | CEO & DIRECTOR GENERAL, ION SPECIALTIES, GRUPO ISON

The flow of materials will shift away from countries with obsolete technologies or uncompetitive costs. More companies are establishing themselves in México, creating local demand we are ready to supply.



MATTHIAS VORBECK | BUSINESS DIRECTOR, ANASTACIO OVERSEAS

Latin America has lived with volatility for decades, so decisions here get made fast — that speed suits our model. Reliable schedules and transparent capacity would do more for our industry than most trade measures.

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**ANTJE GERBER | EVP
INTERNATIONAL CHEMICALS,
SASOL**



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► Nexus Circular, points to a licensing model: “With licensees who want to put steel in the ground at the same time as Nexus is building our own facilities, we can keep more plastic out of landfills.”

Other ripening circularities include Enkern’s biofuels from waste poised for shipping applications, Amphistar’s fermentation of waste into biosurfactants, diversion of the plentiful biodiesel byproduct of glycerol into plant-based acrylonitrile and carbon fiber by Trillium Renewable Chemicals and OrganoClick AB’s use of wheat byproducts in everything from face cream to coffins.

Lummus Technology, a pure-play licensor of proprietary technologies and solutions, specializes in petrochemicals, refining, catalysts and polymers. These same capacities put the company at the vanguard of environmentally restorative chemistries for advanced recycling, PFAS destruction, decarbonization, clean energy and water purification. “Water is life, and if we do not make sure everybody in the world has access to purified water, there are going to be some really serious consequences,” said Leon de Bruyn, the company’s president and CEO.

“None of our customers have backed off environmental compliance—companies with strong sustainability standards continue to maintain them regardless of political shifts,” said Robert Wheatley, chief strategy officer of VLS Environmental Solutions, LLC. Among other solutions, the hazardous and non-hazardous chemical waste specialists have found a process to permanently remove elemental mercury from the biosphere with a first-of-its-kind, patent-pending, fully-permitted solution. This is paramount, Wheatley said, because the U.S. previously had no way to dispose of toxic mercurial waste.

Resilient by design

Companies across the value chain have proven that core capabilities can evolve to unlock new specializations. These strategic transformations take place when larger forces jostle the steady assurance of their bread-and-butter markets.

Film photography household name Eastman Kodak Company had the rug pulled out from under them when the digital advent displaced analog cameras. In a long turnaround, the company pivoted on its own expertise and applied its layering technology to numerous applications in advanced manufacturing and life sciences, while lending its large-scale production infrastructure and know-how to OEMs. “Film is layering and coating at the toughest degree—the material and technology to capture the perfect picture is extremely difficult and we have been doing it for more than 130 years. We asked why we were running away from something we were great at and began putting those capabilities back to work,” recalled CEO Jim Continenza. The long game has carried the company far enough to witness the rebound of the market for film photography.



**MICHAEL LEFENFELD | PRESIDENT
& CEO, HEXION, INC.**

Delivering the next generation of manufacturing will require chemistry, automation, AI, sustainability and process engineering to work together much more closely than they traditionally have.



**GREGORY MULHOLLAND | CO-FOUNDER
& CEO, CITRINE INFORMATICS**

Every company wants to be more sustainable. People are not environmental supervillains at heart—they just need better choices. We help clients get more out of ore to take less out of the ground.



**JOSEPH KRAUSE | FOUNDER & CEO,
RADICAL AI**

Previously, engineers had no choice but to use decades-old materials. Not anymore. With this technology, they will be able to design materials as fast as they design products. This is just the beginning.

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In the tree shadows of the University of Michigan in Ann Arbor, Cayman Chemical founder, president and CEO Kirk M. Maxey hit difficulties from the second American biotech recession after the COVID-19 pandemic, combined with sweeping federal research cuts in 2025 to academic institutions and the government's largest public health and science agencies. The company found growth in forensic chemistry, decoding illicit designer drug composition for regulatory and law enforcement agencies around the world. "I can say in a very hard-headed way that we will react, reposition and survive," said Maxey.

From her vantage point as executive vice president of Sasol International Chemicals, Antje Gerber said speed was still essential to survival. "We have collaborated closely to change our ways of working, increase agility and empower employees to quickly drive decisions," she said, adding, "Without a strong industrial base, transformation cannot be financed or scaled."

Morgan Kaemmerling, co-founder and CEO of U.S.-rooted Bohden Contracting Group, keeps industrial facilities at their best by managing risks and hazards with maintenance, alterations, retrofits, expansions and compliance consulting for everyone from established names in foods and beverages to the \$3 trillion global semiconductor industry.

Adam Dennison, president and CEO of Boston Green Company, keeps customers in the chemical sector compliant and environmentally safe. The company began as the waste oil recovery and collection services of the Dennison Lubricants family business after the Resource Conservation and Recovery Act of 1976. Since becoming independent, the team has expanded to deal with gasoline tank rollovers, frozen pipes, cracked valves on plastic tanks of skin-burning caustics, \$2 million cleanups of wastewater spills into sensitive estuaries and the everyday maintenance in between.

"At the federal level, the Environmental Protection Agency appears to be moving toward a less restrictive regulatory posture in certain areas," Dennison said. "In practice, however, that has had limited impact on our operations because the states in which we primarily work continue to maintain robust environmental standards and enforcement framework."

Aaron Montgomery, president and CEO of Ouray Environmental Services and world-class competitive alpine ice climber, said, of both his roles, "How you manage hazards determines whether they turn into a physical risk." The global company was recently recognized by the American Chemistry Council as a Responsible Care partner, enforcing a set of elective ethical and environmental standards. Montgomery said companies in countries where regulations may not be as strong elect to operate by these because they believe it is the right thing to do. "They want the competent emergency response those principles require. We serve as an extension of that commitment," he said. These companies demonstrate that resilience can lie in repurposing established capabilities to meet new demands and create new paths to growth.



Advanced recycling is a team sport. More companies need to make commitments and signal demand. We all need to step forward and take on a little bit of the risk so in a few years, we are well-positioned to meet EPR compliance targets.

JODIE MORGAN | CEO,
NEXUS CIRCULAR



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At BioRelo, we are entrusted with transporting decades of scientific research and life-changing biological materials. Our mission is simple: ensuring every product arrives safely, on time and at temperature every single time, regardless of distance or complexity.

GEORGE MELASHVILI | CEO,
BIORELO



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A microchip's journey through the value chain

A host of additional connective industries determine the ability of the chemical and material value chain to function safely, effectively and accurately. Many are relatively unseen, but the journey of a microchip tells their story.

Strategic domestication of the total cycle of advanced products like computer chips is bringing increased regulatory action and chemical shipments into the U.S. "There is increasing demand for warehousing of both raw materials and finished goods in the U.S. and around the world, contributing greatly to an increase in our sales pipeline," said Patrick Kelleher, CEO of GXO Logistics. The multibillion-dollar company with 150,000 associates across 27 countries is building up its systems to accommodate the change. The latest development has been piloting warehouse humanoids, which Kelleher expects will deliver a return on investment between 2028 and 2030.

Biological Relocation Solutions (BioRelo) specializes in high-stakes laboratory moves, including a recent cross-country transport from UC San Diego to Columbia University in New York City. "We safeguard decades of scientific research, including stem cells, blood products, reproductive materials, vaccines and cellular therapy products. When we transport clinical material such as cellular therapy products, we help protect the lives of the patients who

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▶ depend on them. And when we transport embryos, we safeguard the hopes and futures of lives yet to begin,” said BioRelo’s founder and CEO George Melashvili.

Packaging is joining the expedition to the next frontier of material storage and transportation, ensuring items ship without spoiling or being damaged. Pepijn Dinandt, CEO of Flint Group Packaging Solutions, said this part of the value chain is underrecognized by industry and the public. “We bring color to the world,” said the executive. Beyond this, the company sources pigments, develops coatings, makes inks dry faster with UV-curable chemistries and helps customers meet shapeshifting ink ordinances and regulations that differ across countries and regions.

The high-purity requirements of semiconductor fabs and life sciences labs depend on filtration and cleanrooms. “The future of filtration is selectivity,” said Dave Mulder, chief technology officer of Donaldson Company, which has kept contaminants out of equipment and demanding applications for 111 years with its filters and systems. “In the past, we measured contaminants in microns and parts per million. Today, we are working with nanoscale particles at concentrations measured in parts per billion or even parts per trillion,” said Mulder.

After exiting a cleanroom, the majority of the world’s semiconductors receive testing and validation at Advantest. Group CEO Douglas Lefever said Advantest detects thermal runaway on wafer surfaces hot as the sun, tests 2 billion transistors arranged as complexly as cities at the sub-two nanometer scales, inspects optical-level data transmission and automates test content, architecture and upgrades. Once the chip gets stacked into a rack of servers, Green Revolution Cooling keeps increasingly dense data centers and edge AI sites in hot, rural areas from breaking down or bursting into flames. CEO Peter Poulin likens liquid-to-liquid cooling to “a nice tub bath” in



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comparison to air and liquid-to-chip technologies. “We have our own Hippocratic oath: do no harm to the servers,” said Poulin, confident in the off-the-shelf, non-conductive cooling fluids the company certifies through its own ElectroSafe program.

Together, these providers form a global nervous system of special, chemical, hazmat and liquid handlers that move products from raw materials to computer chips to end users.

Deep tech at scale

The convergence of scientific expertise, actionable data, hyperaccelerated technologies and evolving consumer preferences is inspiring breakthroughs across industry verticals.

“Beauty is moving into what we call the ‘Beauticellular Era’. Consumers are increasingly looking for products that support skin longevity, regeneration and barrier health at a cellular level,” announced Natale Capri, global head of performance materials at DKSH.

Jan Krueder, CEO of Brazilian Química Anastacio, thinks health benefits are now a consumer prerequisite. “We are seeing bigger demand for products with specific application benefits. The beverage market used to be more about taste but now companies want added fibers, proteins, energy and focus,” he reported.

The shift to precision molecules is also tangible in everything from Hexion’s dynamic wood adhesive formulation recalibrations to agricultural plant health systems that remove the need for pesticides. “Our ability to test and validate products across diverse global markets, environmental conditions and cropping systems is a key strength in developing solutions with broad and consistent relevance,” said Mayank Singhal, vice chairman and managing director of PI Industries, a globally expanding, historic Indian agrochemicals company diversifying into pharmaceuticals and high-value electronic chemicals.

The once fantastical promise of AI-assisted novel materials discovery has arrived. An advocate of human-computer symbiosis, Gregory Mulholland, co-founder and CEO of Citrine Informatics, said, “We need new material, and can use AI as a very talented lab partner to give us more choices to test and prove as we always have.” The company and its platforms have already helped HRL labs reinforce the first 3D-printable aluminum alloys deemed strong enough by the U.S. government for legal use in aerospace applications.

Dr. Venkat Viswanathan, co-founder and CEO of Aionics, said “what is possible now in material science is already greater than what it was six months ago.” The acceleration of AI-optimized discovery means deep tech is no longer theoretical, but real, scalable and on its way to commercialization.

Alexander Hammer, co-founder and CEO of Dunia Innovations, believes systems like his team’s robotics-driven platform could help bring about changes expected in 2050 as early as 2030. He said the ultimate goal is artificial photosynthesis. “Some people are really excited about superconducting magnets for fusion but we also have a big fusion reactor in the sky: the sun. Learning how to harvest this energy would have civilization-scale impacts,” he said.

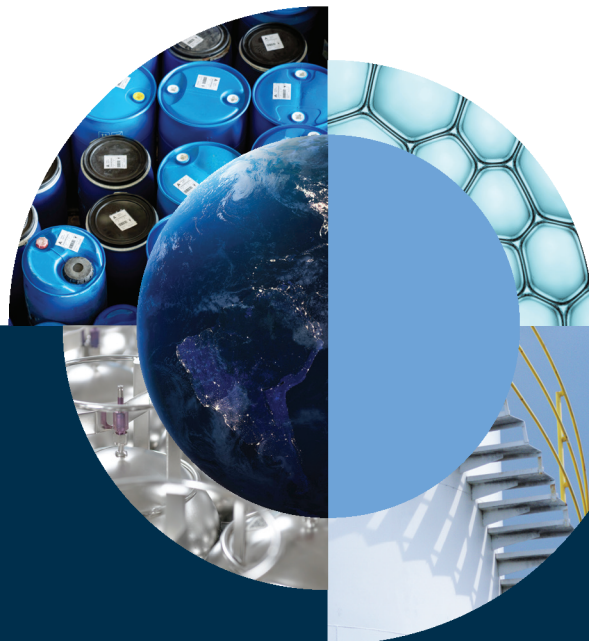
Steve Oldham, CEO of Captura, is taking on decarbonization, critical mineral extraction and ocean health with Direct Ocean Capture (DOC), a process that uses what he considers basic chemistry. Oldham said this technology has proven 10 times more effective than other carbon capture solutions at a quarter of the cost. DOC also returns ocean water to the environment in a less acidic state and allows storage of cheap, off-peak grid energy as acids and bases that can function as “one big battery” when run back through electro dialysis.

Joe Hedley, founder and CEO of the United Kingdom-based cell-free DNA manufacturer NunaBio Limited, just showcased microfoundries that fit into airplane luggage and can make enough DNA for 10 million doses of vaccine in a day with a batch produced in 80 minutes or via continuous production. “Our platforms are designed to help countries establish their own DNA production capabilities within and outside of global crises,” he said, adding that affordability was a priority to help advance treatment for rare conditions underserved from an economics perspective.

Amid this wave of material innovation, environmental health has emerged as a priority. “Fostering economic and human development while being good to the environment are not mutually exclusive goals. The relationship may never be perfect or linear, but these objectives can work in concert,” said Vijay Manthripragada, president, CEO and director of Onterris, Inc. With 76 acquisitions after 14 years, the company has contributed water treatment technology to Australia, helped residents monitor air quality in Denver, Colo. and is building the largest PFAS removal plants in the world for 3M.

Manthripragada sees sectors blending together like specialty chemicals, with environmental health considerations entering the C-suite as the macro business decisions they are. “Acknowledging the benefits from chemicals, the challenge is managing and mitigating risk rather than creating a boogeyman to be angry at,” he said, revering chemistry as the substrate for every headlining technology and market trend. “The very technologies people fear will be the transformation in protecting the environment,” he added, looking hopefully upon AI tools.

Over the next decade, adaptability will be the industry’s defining currency. Those who turn disruption into a competitive edge will lead the future. Driven by the limitless power and material demands of AI, leadership will be reserved for companies able to innovate and consolidate chemistry, circularity, efficient energy infrastructure and digital know-how to set the foundation of global economic growth.



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