





An acetylene plant at BASF's site in Ludwigshafen, Germany

c&en's GLOBAL TOP 50

Despite challenges, chemical makers posted a strong performance

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The global chemical industry confronted exceptional challenges in 2022, but overall it ended the year in decent shape.

According to C&EN's Global Top 50 survey, the world's 50 largest chemical companies combined for chemical sales of \$1.2 trillion in 2022, the fiscal year on which the survey is based. That is a 17% increase over the results from the same companies in 2021.

The lofty results do come with disclaimers. For the most part, firms attributed the increase in sales to higher selling prices, not increased production volumes. And in 2021, the Global Top 50 posted a 38% increase in sales as the world economy rebounded from the depths of the COVID-19 pandemic.

The picture appears less rosy when chemical profits are measured. The 42 companies in the Global Top 50 that report such data combined for \$117.7 billion in chemical profits, a decline of 7% from those firms' profits in 2021.

But this is a modest decrease considering 2022's many headwinds. One was Russia's invasion of Ukraine. It drove up energy prices during the first half of the year and disrupted supplies of natural gas to Europe. Germany, with its dependence on Russian gas, was hit particularly hard. Firms such as BASF had to shut down chemical capacity.

Around the world, central banks raised interest rates to combat inflation, slowing economic growth. And China, long the engine driving chemical industry output, had a difficult year as stringent lockdowns to

combat the COVID-19 pandemic crimped economic activity.

Certain sectors of the industry performed very well. Fertilizer makers such as Yara,

Nutrien, and Mosaic saw big increases in sales from higher prices. Three firms—CF Industries, ICL Group, and OCI—made the Global Top 50 for the first time because of the strong fertilizer market.

Similarly, the lithium-chemical business has been booming because of demand for electric vehicle batteries. This demand thrust the Chilean inorganic firm SQM into the ranking for the first time.

Alpek made the Global Top 50 on the strength of its core polyester business. The Mexican chemical maker saw sales rise by 36%. Indorama Ventures,

another polyester specialist, also experienced a strong rise in sales, at 41%.

A newcomer is Japan's Resonac Holdings, which formed from the merger between Showa Denko and Showa Denko Materials, formerly Hitachi Chemical. The US petrochemical maker Westlake also returns to the Global Top 50 after narrowly missing out last year.

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Many firms dropped from the ranking after appearing in it last year. Lanxess and DSM, two European chemical makers, didn't make the cut. Both firms divested large polymer businesses recently.

The Chinese chemical makers Hengyi Petrochemical and Tongkun Group were also edged out by other companies. The fast-growing firms will likely be back on the survey in the future.

Hanwha Solutions and Johnson Matthey both dropped from the list. In tabulating Hanwha's results, C&EN excluded nonchemical photovoltaic sales, which we had counted in previous years. Johnson Matthey saw a sharp drop in sales in its automotive catalyst business during the fiscal year.

EuroChem Group, a fertilizer maker that has Russian ownership and a largely Russian business, didn't publicly report results for 2022.

1 BASF

2022 chemical sales: \$92.0 billion

BASF managers would probably prefer to forget about 2022. The overall results for the world's largest chemical company look good: revenues increased 11% while chemical operating profits declined a mere 2%. But the company's home base of Germany was hurt deeply by the European energy crisis. Russia's invasion of Ukraine severely reduced European imports of Russian natural gas. BASF's 2022 European energy bill increased by \$2.9 billion over the year before. BASF was forced to shut down some chemical capacity in Ludwigshafen, Germany, its flagship site.

It closed ammonia and nitrogen fertilizer capacity because costs were too high. It is closing a plant to make the nylon 6 feedstock caprolactam and is reducing capacity for the nylon 6,6 raw material adipic acid.

Because of weak European polyurethane demand, the company is closing capacity for toluene diisocyanate and its precursors. What's more, BASF took a write-down of \$6.7 billion because its Winterhall Dea oil and gas affiliate withdrew from Russia. "The past year has taught us all a harsh lesson: peace and economic stability must never be taken for granted," BASF chairman Martin Brudermüller remarked to stock analysts in February.

2 Sinopec

2022 chemical sales: \$66.9 billion

Sinopec is hitching up with another company high in C&EN's ranking, Ineos. The two firms are forming joint ventures that they estimate will generate \$10 billion in annual revenues. Ineos bought into Sinopec's existing ethylene cracker complex and is buying a stake in a cracker in Tianjin, China, that is under construction and set for completion later this year. The companies also plan on running high-density polyethylene and acrylonitrile-butadiene-styrene polymer plants together. Like many large chemical makers, Sinopec is making a push into green hydrogen. It is building a plant in Inner Mongolia that will make 30,000 metric tons (t) of hydrogen annually via water electrolysis with renewable energy. An affiliate will use the hydrogen to make chemicals, such as olefins and methanol, from coal. Sinopec

says that compared with using coal to generate the needed hydrogen, the process will cut nearly 1.5 million t per year of carbon dioxide emissions.

3 Dow

2022 chemical sales: \$56.9 billion

Dow plans to become the first major company to build a nuclear power plant at a chemical complex to reduce greenhouse gas emissions. In May, the company selected Seadrift, Texas, as the site for installing a modular nuclear reactor designed by X-Energy Reactor. Set to come on line by the end of the decade, the reactor will supply heat and steam to the petrochemical complex, cutting 440,000 metric tons of carbon dioxide emissions per year. Nuclear power has advantages over other low-carbon energy sources, such as wind and solar, in that it produces electricity more steadily because it doesn't depend on the weather. Dow has diversified wagers on low-carbon energy. In Alberta, the company is converting the heat source for its ethylene cracker to hydrogen and will use carbon capture and storage to mitigate CO₂ emissions from the hydrogen production. It also plans to buy ethylene made from cellulosic ethanol that the start-up New Energy Blue will produce from corn stover in Iowa.

4 Sabic

2022 chemical sales: \$48.8 billion

Since its inception in 1976 as a state-owned chemical maker charged with upgrading Saudi Arabia's hydrocarbon resources into chemicals, Sabic has always had big-ticket construction projects in the works. Last year, the company started up a \$10 billion petrochemical project in Texas with ExxonMobil. Now Sabic is studying the construction of a large oil-to-chemical complex in Ras al-Khair, Saudi Arabia. In addition, Sabic and SK Geo Centric are expanding a joint venture in Ulsan, South Korea, that uses SK's Nexlene technology to make low-density polyethylene, elastomers, and plastomers. Sabic is also considering installing a Nexlene plant at Motiva Enterprises' refinery in Port Arthur, Texas. Like Sabic, Motiva is controlled by the oil company Saudi Aramco.

5 ExxonMobil

2022 chemical sales: \$47.5 billion

ExxonMobil is serious about making a business out of carbon sequestration. It is moving forward with a project in Baytown, Texas, to capture and store 7 million metric tons (t) per year of



Sabic's Saudi Methanol (Ar-Razi) methanol joint venture with Japan Saudi Arabia Methanol, in Jubail, Saudi Arabia

Global Top 50

Many of the world's largest chemical producers saw profits decline in 2022.

RANK		COMPANY	2022 CHEMICAL SALES (\$ MILLIONS)	CHANGE FROM 2021	2022 CHEMICAL SALES AS % OF TOTAL SALES	SECTOR	2022 CHEMICAL OPERATING PROFIT ^b (\$ MILLIONS)	CHANGE FROM 2021	2022 CHEMICAL OPERATING PROFIT MARGIN ^c	HEADQUARTERS	2022 IDENTIFIABLE CHEMICAL ASSETS (\$ MILLIONS)	2022 OPERATING RETURN ON CHEMICAL ASSETS ^d
2022	2021 ^a											
1	1	BASF	\$91,991	11.1%	100.0%	Diversified	\$8,044	-1.6%	8.7%	Germany	\$88,983	9.0%
2	2	Sinopec	66,862	5.9	13.8	Petrochemicals	-2,119	n.m.	def.	China	36,082	def.
3	3	Dow	56,902	3.5	100.0	Diversified	5,702	-27.7	10.0	US	60,603	9.4
4	4	Sabco	48,821	12.9	92.2	Petrochemicals	6,196	-29.4	12.7	Saudi Arabia	78,259	7.9
5	5	ExxonMobil	47,498	12.7	11.9	Petrochemicals	7,356	-43.2	15.5	US	44,372	16.6
6	8	Ineos	41,188	15.8	100.0	Diversified	3,813	-20.2	9.3	England	36,507	10.4
7	6	Formosa Plastics ^g	40,231	-0.6	65.3	Petrochemicals	n/a	n/a	n/a	Taiwan	n/a	n/a
8	10	LG Chem ^h	40,150	21.6	100.0	Diversified	2,319	-40.4	5.8	South Korea	52,620	4.4
9	7	LyondellBasell Industries	39,476	1.2	78.2	Petrochemicals	4,168	-48.0	10.6	US	n/a	n/a
10	9	PetroChina	38,314	7.9	8.0	Petrochemicals	-89	n.m.	def.	China	n/a	n/a
11	12	Hengli Petrochemical ⁱ	31,126	16.1	94.2	Petrochemicals	n/a	n/a	n/a	China	n/a	n/a
12	15	Air Liquide	31,033	28.4	98.4	Industrial gases	2,925	18.2	9.4	France	48,067	6.1
13	11	Linde	30,602	9.6	91.7	Industrial gases	7,349	9.6	24.0	England	n/a	n/a
14	13	Mitsubishi Chemical Group	29,369	14.4	83.3	Diversified	1,383	-35.0	4.7	Japan	37,296	3.7
15	14	Syngenta Group	28,500	14.5	85.3	Agricultural chemicals	n/a	n/a	n/a	Switzerland	n/a	n/a
16	26	Rongsheng Petrochemical	26,607	73.5	61.9	Petrochemicals	n/a	n/a	n/a	China	n/a	n/a
17	17	Reliance Industries ^g	25,225	18.7	20.3	Petrochemicals	n/a	n/a	n/a	India	n/a	n/a
18	16	Wanhua Chemical	24,605	13.8	100.0	Diversified	3,220	-32.5	13.1	China	29,847	10.8
19	22	Yara	23,902	43.8	100.0	Fertilizers	3,827	258.3	16.0	Norway	17,982	21.3
20	24	Shin-Etsu Chemical ^f	21,367	35.4	100.0	Diversified	7,593	47.6	35.5	Japan	35,984	21.1
21	19	Shell ^g	21,064	24.0	8.1	Petrochemicals	n/a	n/a	n/a	England	n/a	n/a
22	25	Evonik Industries	19,475	23.6	100.0	Specialty chemicals	1,245	-9.3	6.4	Germany	22,975	5.4
23	31	Mosaic	19,125	54.8	100.0	Fertilizers	5,258	89.8	27.5	US	23,386	22.5
24	30	Indorama Ventures	18,989	40.8	100.0	Petrochemicals	1,418	18.1	7.5	Thailand	17,800	8.0
25	20	Covestro	18,928	13.0	100.0	Diversified	259	-89.0	1.4	Germany	15,364	1.7
26	35	Nutrien	18,867	62.8	49.8	Fertilizers	10,189	111.2	54.0	Canada	28,389	35.9
27	18	Braskem	18,704	-8.6	100.0	Petrochemicals	1,184	-77.5	6.3	Brazil	17,062	6.9
28	29	Lotte Chemical	17,245	22.9	100.0	Diversified	-590	n.m.	def.	South Korea	20,735	def.
29	34	Solvay	16,929	40.6	100.0	Specialty chemicals	2,388	65.7	14.1	Belgium	21,764	11.0
30	23	Sumitomo Chemical	16,925	5.6	79.2	Diversified	654	-50.5	3.9	Japan	19,713	3.3
31	27	Toray Industries	16,662	11.7	88.0	Diversified	742	-27.6	4.5	Japan	n/a	n/a
32	36	Bayer	15,076	32.9	28.2	Agricultural chemicals	n/a	n/a	n/a	Germany	n/a	n/a
33	32	Mitsui Chemicals	14,298	16.5	100.0	Diversified	737	-30.5	5.2	Japan	15,733	4.7
34	28	Chevron Phillips Chemical	14,180	0.5	100.0	Petrochemicals	n/a	n/a	n/a	US	18,656	n/a
35	33	Umicore	13,197	9.2	49.3	Specialty chemicals	530	9.9	4.0	Belgium	8,812	6.0
36	21	DuPont	13,017	-21.8	100.0	Diversified	2,022	-23.8	15.5	US	41,355	4.9
37	39	Air Products and Chemicals	12,699	23.0	100.0	Industrial gases	2,357	6.4	18.6	US	27,193	8.7
38	40	Arkema	12,167	21.3	100.0	Specialty chemicals	1,519	29.2	12.5	France	14,233	10.7
39	—	CF Industries Holdings	11,186	71.1	100.0	Fertilizers	5,571	157.4	49.8	US	13,313	41.8
40	—	Westlake	11,008	27.0	69.7	Petrochemicals	2,416	-5.2	21.9	US	13,978	17.3
41	—	SQM	10,711	274.2	100.0	Inorganic chemicals	5,594	476.0	52.2	Chile	10,819	51.7
42	—	Resonac Holdings ^h	10,594	-1.9	100.0	Diversified	452	-31.9	4.3	Japan	15,978	2.8
43	38	Eastman Chemical	10,580	1.0	100.0	Diversified	1,147	-21.0	10.8	US	14,667	7.8
44	—	Alpek	10,558	36.0	100.0	Petrochemicals	1,197	29.2	11.3	Mexico	6,800	17.6
45	41	Asahi Kasei	10,015	9.9	48.3	Specialty chemicals	312	-62.8	3.1	Japan	13,321	2.3
45	—	ICL Group	10,015	44.0	100.0	Inorganic chemicals	3,492	190.0	34.9	Israel	11,750	29.7
47	42	Borealis	9,831	8.6	100.0	Petrochemicals	741	-50.1	7.5	Austria	15,470	4.8
48	44	Sasol	9,805	20.5	58.2	Diversified	1,993	65.1	20.3	South Africa	n/a	n/a
49	—	OCI	9,713	53.7	100.0	Fertilizers	2,975	90.4	30.6	Netherlands	9,771	30.4
50	48	PTT Global Chemical	9,696	51.8	49.7	Diversified	189	-71.1	1.9	Thailand	n/a	n/a

Sources: Company documents, C&EN analysis. **Note:** Some figures were converted at 2022 average exchange rates of US\$1.00 = 5.1605 Brazilian reais, 6.729 Chinese yuan, 0.9493 euros, 78.5792 Indian rupees, 131.4589 Japanese yen, 29.7963 New Taiwan dollars, 3.75 Saudi riyals, 16.3598 South African rand, 1,291.7796 South Korean won, and 35.05 Thai baht. *def.* means deficit, *n/a* means not available, and *n.m.* means not meaningful. **a** Prior-year rankings have been revised from the July 25, 2022, issue of C&EN to reflect restated prior-year results and changes in exchange rates. Comparisons with prior years also use revised numbers. **b** Chemical sales less administrative expenses and cost of sales. **c** Chemical operating profit as a percentage of chemical sales. **d** Chemical operating profit as a percentage of identifiable chemical assets. **e** C&EN estimates. **f** Chemical sales include a significant number of nonchemical products.

carbon dioxide generated during hydrogen production. ExxonMobil will use this low-carbon, blue hydrogen for its chemical operations and to make ammonia. South Korea's SK has already agreed to buy ammonia from the complex. In January, ExxonMobil awarded the engineering contract to Technip Energies. The oil and gas company is also eager to provide CO₂ transport and storage to third parties. Over the past year it has signed contracts with the fertilizer maker CF Industries, the industrial gas supplier Linde, and the steelmaker Nucor covering 5 million t of CO₂ per year. ExxonMobil is also planning a hub in the UK that would capture and store 3 million t per year of the greenhouse gas.

6 Ineos

2022 chemical sales: \$41.2 billion

Long a major European and US player in petrochemicals and plastics, Ineos is now making a push into Asia. Last year, it signed a series of deals with Chinese oil and chemical producer Sinopec that could together generate about \$10 billion in annual sales. Ineos purchased a 50% interest in Shanghai Secco Petrochemical, which had once been a joint venture with BP. Ineos and Sinopec also agreed to join on future projects in acrylonitrile-butadiene-styrene polymer and high-density polyethylene. Ineos bought Mitsui Chemicals' phenol complex on Jurong Island, Singapore, for \$330 million in April. In Europe, Ineos is buying out TotalEnergies' interest in an ethylene cracker joint venture in Lavéra, France. Ineos may soon be diversifying in dramatic fashion. The firm is reportedly in the running to buy Manchester United. Ineos founder Jim Ratcliffe has always been a supporter of the soccer club.

7 Formosa Plastics

2022 chemical sales: \$40.2 billion

Some chemical projects remain in a holding pattern forever. They aren't canceled formally; they are just quietly shelved. One of these might be Formosa Plastics' \$9.4 billion petrochemical project in Louisiana, originally announced in 2015. The plan has always faced stiff opposition from the local community and activists, who have scored major victories. In 2021, the US Army Corps of Engineers ordered a full environmental review, and last year a local judge pulled the air permits. Formosa's project website hasn't been updated since 2021, and the firm still hasn't reached a final investment decision. The company is, however, pressing on with a more modest project in its home country: an expansion

of its styrenic block copolymer joint venture with Kraton in Mailiao, Taiwan.

8 LG Chem

2022 chemical sales: \$40.2 billion

LG Chem is stepping up investment in battery materials. In November, the South Korean firm revealed plans to build

the largest cathode material facility in the US. The \$3 billion plant, in Clarksville, Tennessee, will have the capacity for 120,000 metric tons per year of nickel, cobalt, manganese, and aluminum cathode materials. A few months earlier it signed an agreement to supply cathode materials to General Motors. This April, LG Chem and Huayou Cobalt announced a joint venture

Spending

Both chemical capital expenditures and chemical R&D investment increased substantially for many firms in 2022.

	CHEMICAL CAPITAL SPENDING			CHEMICAL R&D SPENDING		
	2022 (\$ MILLIONS)	CHANGE FROM 2021	% OF CHEMICAL SALES	2022 (\$ MILLIONS)	CHANGE FROM 2021	% OF CHEMICAL SALES
Air Liquide	\$3,351	10.8%	10.8%	\$324	1.3%	1.0%
Air Products and Chemicals	2,927	18.8	23.0	103	10.1	0.8
Alpek	152	-30.6	1.4	3	1.5	0.0
Arkema	745	-7.3	6.1	284	11.1	2.3
Asahi Kasei	810	-11.8	8.1	318	23.7	3.2
BASF	4,609	23.9	5.0	2,421	3.7	2.6
Borealis	702	1.0	7.1	10	-47.8	0.1
Braskem	940	41.7	5.0	73	26.3	0.4
CF Industries Holdings	453	-11.9	4.0	n/a	n/a	n/a
Covestro	876	8.9	4.6	380	5.9	2.0
Dow	1,823	21.5	3.2	851	-0.7	1.5
DuPont	743	-16.6	5.7	536	-13.3	4.1
Eastman Chemical	611	10.1	5.8	264	3.9	2.5
Evonik Industries	911	0.0	4.7	485	-0.9	2.5
ExxonMobil	2,955	109.0	6.2	n/a	n/a	n/a
Hengli Petrochemical	n/a	n/a	n/a	176	16.2	0.6
ICL Group	747	22.3	7.5	68	6.3	0.7
Indorama Ventures	731	28.4	3.9	42	116.0	0.2
Ineos	2,008	22.2	4.9	79	-4.1	0.2
LG Chem	6,508	45.6	16.2	1,366	30.0	3.4
Linde	3,255	3.4	10.6	n/a	n/a	n/a
Lotte Chemical	2,007	235.3	11.6	79	10.8	0.5
LyondellBasell Industries	1,830	-1.4	4.6	124	0.0	0.3
Mitsubishi Chemical Group	1,856	19.2	6.3	n/a	n/a	n/a
Mitsui Chemicals	1,007	23.6	7.0	327	12.9	2.3
Mosaic	1,247	-3.2	6.5	n/a	n/a	n/a
OCI	394	58.3	4.1	n/a	n/a	n/a
Resonac Holdings	668	29.7	6.3	198	-8.9	1.9
Sabco	2,569	-7.4	5.3	n/a	n/a	n/a
Shin-Etsu Chemical	2,248	50.9	10.5	511	7.7	2.4
Sinopec	8,710	13.5	13.0	n/a	n/a	n/a
Solvay	859	45.3	5.1	376	9.8	2.2
SQM	905	94.8	8.5	n/a	n/a	n/a
Sumitomo Chemical	866	33.2	5.1	n/a	n/a	n/a
Umicore	382	25.8	2.9	259	19.7	2.0
Wanhua Chemical	n/a	n/a	n/a	508	8.0	2.1
Westlake	913	61.0	8.3	n/a	n/a	n/a
Yara	926	14.5	3.9	95	1.1	0.4

Sources: Company documents, C&EN analysis. Note: Figures are for companies on the top 50 list reporting capital or R&D expenditures or both. n/a means not available. Some figures were converted at 2022 average exchange rates listed on page 23. Comparisons with prior years are based on revised numbers that reflect restated prior-year results and changes in exchange rates.

to build a \$900 million plant for cathode precursors near Seoul, South Korea. In South Korea, the company started construction on a plant for carbon nanotubes, which are used in cathodes. LG Chem is also active in biobased chemicals. With ADM, it's building lactic acid and polylactic acid plants in Decatur, Illinois, that will start up in 2026. And with the industrial biotechnology firm Gevo it is working on a biobased route to the chemical building block propylene.

9 LyondellBasell Industries

2022 chemical sales: \$39.5 billion

LyondellBasell Industries has ambitious plans in circularity. In Wesseling, Germany, near Cologne, the company is building the first plant to use its MoReTec technology, a catalytic process that breaks down waste plastics into petrochemical feedstocks. LyondellBasell's vision is for Wesseling to become an integrated center for recycling all kinds of plastic waste. Some would be mechanically recycled. Plastics that don't lend themselves to mechanical recycling, such as flexible packaging, would go through chemical processes like MoReTec. LyondellBasell aims to establish a similar system in the US as part of a plan to repurpose its Houston refinery, which the company has slated to close in early 2025. The firm is also considering low-carbon hydrogen projects at the location.

10 PetroChina

2022 chemical sales: \$38.3 billion

The Chinese economy struggled in 2022 as the government imposed severe lockdowns and other restrictions to fight the COVID-19 pandemic. PetroChina's results show it. The company's chemical business posted a loss for the year, and revenues rose by only 8%. The sales increase was primarily due to rising prices, not improving volumes. The company is still making progress on big projects. It recently completed a 600,000-metric-ton-per-year acrylonitrile-butadiene-styrene polymer plant in Jieyang, China. And the company is working on expansions at its PetroChina Guangxi Petrochemical and PetroChina Jilin Petrochemical subsidiaries. The total budget for these projects is \$9.5 billion.

11 Hengli Petrochemical

2022 chemical sales: \$31.1 billion

As a large Chinese petrochemical maker, Hengli Petrochemical was hit with weak domestic demand in 2022 because of pandemic lockdowns and rising prices for oil.

"Confronted with formidable challenges, we have cut through thickets and advanced toward the light, steadfastly growing amidst tremendous changes and uncertainty, resolute in our forward pursuit," chair Fan Hongwei writes in a letter to shareholders in the company's annual report earlier this year. Hengli is indeed pursuing a lot this year. The company is starting up plants for acrylonitrile-butadiene-styrene polymer, polycarbonate, adipic acid, and butanediol. It is also installing capacity for lithium-ion battery separators.

12 Air Liquide

2022 chemical sales: \$31.0 billion

In recent years, the French industrial gas specialist Air Liquide has heaped a lot of investment onto electronics and low-carbon technologies. It is spending \$70 million in North Texas to expand plants that make high-purity oxygen and nitrogen for semiconductor producers

from natural gas. Dow will use the hydrogen as a fuel for its nearby ethylene cracker. The carbon dioxide generated in the process will be captured and stored. Additionally, Linde plans to spend \$1.8 billion to build an autothermal reformer that will supply hydrogen to an ammonia plant that OCI is planning for Beaumont, Texas. As part of that project, Linde has chosen ExxonMobil to transport and store the CO₂. In a similar venture, Linde plans to install an electrolyzer in Niagara Falls, New York, to make hydrogen from water using hydroelectric power.

14 Mitsubishi Chemical Group

2022 chemical sales: \$29.4 billion

Mitsubishi Chemical Group CEO Jean-Marc Gilson is worried about the future of the Japanese petrochemical industry. The sector has been suffering under high energy prices, a weak Japanese yen, and



LG Chem's carbon nanotube plant in Yosu, South Korea

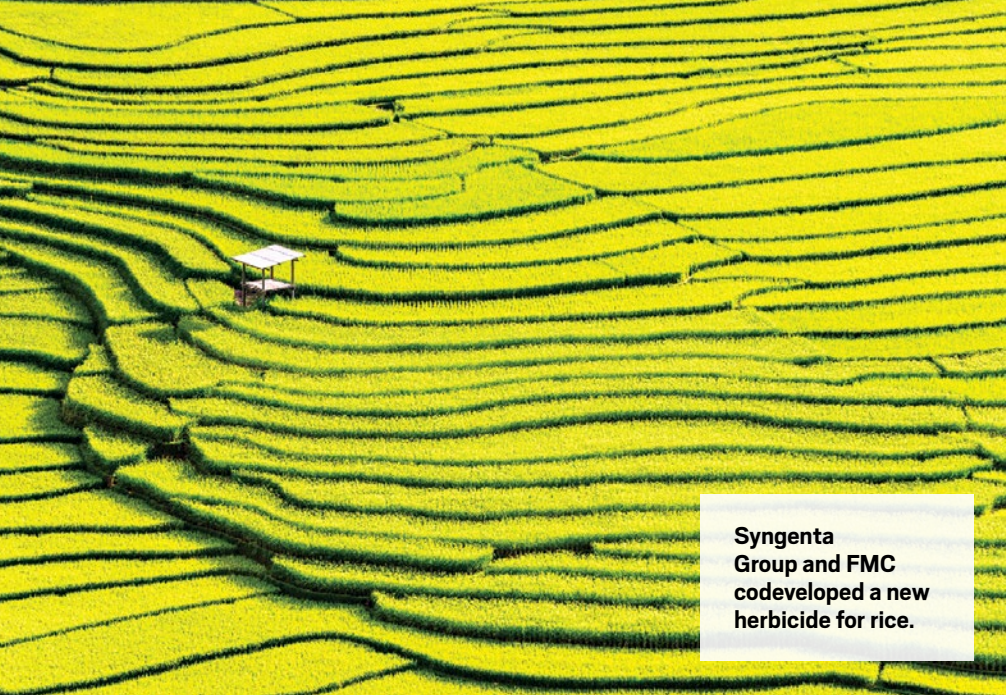
and to build a new plant. At the same time, the company is negotiating the sale of its aerospace O₂ and N₂ business to Safran Aerosystems. In low-carbon technologies, the firm's Cryocap technology will be installed at a carbon capture project at a Holcim cement factory in Belgium. The plant will capture CO₂ using cryogenic temperatures instead of the more typical amine solvents.

13 Linde

2022 chemical sales: \$30.6 billion

The industrial gas maker Linde is positioning itself as a third-party supplier of low-carbon hydrogen. For example, it will build an autothermal reformer at its site in Alberta that will generate hydrogen

stiff competition from energy-rich regions like the Middle East. "It's forcing consolidation in Japan, because four or five players can't survive there," he told a petrochemical conference in Houston in March. Mitsubishi plans to carve out its petrochemical and coal-based operations as a separate company. Mitsubishi will instead focus on specialty chemicals, which have a stronger future in Japan. To this end, Mitsubishi has opened a research facility in Yokohama, Japan. The company is setting priorities abroad as well. It is considering closing its methyl methacrylate (MMA) plant in Billingham, England, that has made the acrylic monomer since 1930. It has also delayed a final investment decision on a new MMA plant in Louisiana.



Syngenta Group and FMC codeveloped a new herbicide for rice.

15 Syngenta Group

2022 chemical sales: \$28.5 billion

In May, Syngenta Group, the crop protection arm of the Chinese conglomerate Sinochem Holdings, introduced what it is calling a breakthrough herbicide—tetflupyrolimet—for the control of grass weeds that affect rice in Asia. Developed by FMC with Syngenta’s support, tetflupyrolimet is the first major herbicide with a novel mode of action in 3 decades, according to the companies. Syngenta is also investing in biological crop protection technologies. It is working with Biotalys on biological insecticides. And in September, Syngenta was named the exclusive distributor of a microbial seed treatment, made by Bioceres Crop Solutions, that improves nitrogen uptake for soybeans.

16 Rongsheng Petrochemical

2022 chemical sales: \$26.6 billion

The up-and-coming Chinese chemical maker Rongsheng Petrochemical is getting backing from a big international partner. In March, Saudi Aramco—the Saudi oil company that controls Sabic, which is number 4 in C&EN’s ranking—said it will purchase a 10% stake in Rongsheng for \$3.6 billion. It will also supply 480,000 barrels of oil per day to Rongsheng. The supply comes at an opportune time. In 2022, Rongsheng subsidiary Zhejiang Petroleum and Chemical doubled its refining and petrochemical capacity to 40 million metric tons per year. Rongsheng has investment projects slated for polycarbonate, acrylonitrile-butadiene-styrene polymer, α -olefins, adiponitrile, and polymethyl methacrylate.

17 Reliance Industries

2022 chemical sales: \$25.2 billion

Last August, the Indian conglomerate Reliance Industries unveiled a \$9.4 billion spending program in chemicals. As part of the plan, Reliance will build what it bills as the largest plant in the world that will make purified terephthalic acid in a single production line. The unit, in Dahej, India, will have 3 million metric tons of annual capacity. Reliance is also making a major push in polyvinyl chloride; it is planning integrated complexes in Dahej and Jamnagar, India, and in Ruwais, Abu Dhabi. Reliance nods to sustainable technologies as well. The company developed its own catalytic pyrolysis technology for recycling plastic and is designing a commercial-scale plant. And it invested \$12 million in Caelux, a US firm that coats silicon-based solar panels with perovskite, which improves efficiency.

18 Wanhua Chemical

2022 chemical sales: \$24.6 billion

After a few years of meteoric rise, Wanhua Chemical’s growth fell back to earth in 2022. The polyurethane chemical maker’s revenues increased 14% in 2022. Not bad, but the previous year, its sales nearly doubled. The Chinese company continues to make steady progress on projects. It completed a 400,000-metric-ton-per-year methylene diphenyl diisocyanate plant in Fujian, China, despite such obstacles as abnormally high temperatures and a typhoon. It also started up a butanediol plant in Sichuan, China. In 2024, it aims to complete a \$3.6 billion petrochemical complex centered on a propane dehydrogenation plant.

19 Yara

2022 chemical sales: \$23.9 billion

Yara had been targeting its home base of Europe for its low-carbon ammonia initiatives, but this year the Norwegian firm announced two big projects in the US. In April, Yara signed a letter of intent to develop a \$2.9 billion project with the energy firm Enbridge. The plant will be located at Enbridge’s site in Ingleside, Texas, and be able to make up to 1.4 million metric tons of ammonia per year. The ammonia will be made from natural gas with the capture and storage of 95% of the carbon dioxide emissions. And last month, Yara and BASF said they were considering a similar US blue ammonia project. The companies already have a conventional ammonia joint venture in Freeport, Texas.

20 Shin-Etsu Chemical

2022 chemical sales: \$21.4 billion

Shin-Etsu Chemical lost a giant on Jan. 1 when its chair, Chihiro Kanagawa, died at age 96. His tenure with the company lasted 60 years. A key Kanagawa accomplishment was founding Shin-Etsu’s US polyvinyl chloride (PVC) arm, Shintech, in 1973. Among Japanese firms, Shin-Etsu was an outlier in 2022, raking in a 48% increase in profits while most of its peers saw a decrease. One challenge for the firm has been that US PVC business. High interest rates threaten to slow new construction, a key driver for PVC demand.

21 Shell

2022 chemical sales: \$21.1 billion

Earlier this month, Shell’s chemical and refining business got new leadership when Machteld de Haan became the firm’s executive vice president for chemicals and products. She replaced Robin Mooldijk, who became project and technology director. De Haan has been with Shell for 25 years, most recently running its global lubricant business. She took over at an interesting juncture for the company. In November, Shell started up an ethylene cracker and polyethylene project in Monaca, Pennsylvania. The company is also looking to transform itself and decarbonize. For example, it is reviewing its Singapore operations to see how it can best reduce carbon emissions.

22 Evonik Industries

2022 chemical sales: \$19.5 billion

Evonik Industries is making modest progress toward divesting the businesses in its performance materials division.

The company wants to focus on specialty chemical businesses with higher growth and profitability. Under the program, unveiled last year, Evonik aims to divest businesses such as C₄ chemicals, isononyl alcohol, and superabsorbent polymers by the end of 2023. So far, its largest slated divestiture is the sale of sites in Lülldorf and Wesseling, Germany, to International Chemical Investors Group. The performance material facilities at these sites generated \$280 million in sales last year.

23 Mosaic

2022 chemical sales: \$19.1 billion

Mosaic continues to make a tremendous amount of money because of an ongoing fertilizer boom. The phosphorus and potassium fertilizer maker's sales climbed 55% in 2022, and its profits nearly doubled. Escalating prices tell the whole story. Prices for diammonium phosphate increased to \$804 per metric ton last year, from \$310 in 2020. Similarly, muriate of potash prices over the same 2-year period increased from \$181 to \$632 per metric ton. The company may be best known for its phosphate-mining operations in Florida. But nowadays, its biggest business segment is Mosaic Fertilizantes, a Brazilian potash and phosphate producer with \$8.3 billion in annual sales.

24 Indorama Ventures

2022 chemical sales: \$19.0 billion

The Thai chemical maker Indorama Ventures continues to branch out from its core polyester business. It bought Old World Industries' chemical business, a maker of ethylene oxide and the polyester raw material ethylene glycol, in 2012. It then acquired Huntsman's intermediates and surfactant business in 2020 and the ethoxylated surfactant maker Oxiteno in 2022. Now Indorama is expanding further. It and Shenzhen Capchem Technology recently canceled plans to build a plant for lithium-ion battery solvent at one of Indorama's US facilities. It would have made ethylene carbonate and other carbonates from raw materials such as ethylene oxide and carbon dioxide. Indorama would still like to proceed with a new partner. And Indorama and Origin Materials plan to refurbish one of Indorama's plants to convert the cellulose-derived chemical chloromethylfurfural into polyester.

25 Covestro

2022 chemical sales: \$18.9 billion

Like many German chemical makers, Covestro has been struggling on its home

turf because of high energy prices. Back in 2021, it announced plans to cut 10% of its workforce by the end of this year, mostly in Germany. The company is also discontinuing its Maezio line of fiber-reinforced thermoplastic composite products, made in Markt Bibart, Germany. Covestro is once again shelving plans to build a large methylene diphenyl diisocyanate plant in either the US or China. The reason, it says, is high inflation and a poor European economy. It canceled an earlier US project in 2020. Perhaps sniffing a bargain, Abu Dhabi National Oil Company reportedly made an \$11 billion bid to acquire Covestro, which Covestro rejected.

26 Nutrien

2022 chemical sales: \$18.9 billion

Nutrien makes all three of the basic fertilizers: nitrogen, phosphorus, and potassium. And like other fertilizer makers, it has seen its results swell. Nutrien's sales climbed 63% in 2022 because of rising prices, and its profits more than doubled. This would seem like a strange time to encourage farmers to apply less fertilizer, but that is exactly what Nutrien is attempting. It is piloting a program that pays farmers to use fertilizer more efficiently. The Canadian firm will then sell credits resulting from the carbon savings that such efficiency creates.

27 Braskem

2022 chemical sales: \$18.7 billion

Novonor, Braskem's controlling shareholder, has been aiming to sell its stake in the Brazilian petrochemical maker for several years. It may finally have good

prospects. In May, Novonor received a purchase proposal from Abu Dhabi National Oil Company and Apollo Global Management that valued Braskem at about \$7.6 billion. Then in June, it got an offer worth \$8.6 billion from the Brazilian polyvinyl chloride maker Unipar Carbocloro. The much smaller firm would have to come up with the financing. But because Unipar is a Brazilian company, the deal would be more likely to win government approval than one involving a big foreign oil company and a private equity firm.

28 Lotte Chemical

2022 chemical sales: \$17.2 billion

Lotte Chemical is assessing a pair of clean ammonia projects in the US. The South Korean company is participating in a consortium with Mitsubishi Corporation and the energy firm RWE that is studying an ambitious project in Corpus Christi, Texas, that would ultimately have 10 million metric tons per year of clean ammonia capacity. The partners are planning both blue ammonia, made from natural gas with carbon capture and storage, as well as green ammonia, made with hydrogen created via electrolysis. Lotte is also looking at a blue ammonia project with the fertilizer maker CF Industries that might be located in Ascension Parish, Louisiana.

29 Solvay

2022 chemical sales: \$16.9 billion

Solvay is putting the final touches on its plan to split in two by the end of this year. In June, the Belgian company unveiled the name for the firm that will run its



Evonik Industries' facility in Darmstadt, Germany



Workers at Solvay's facility in Baton Rouge, Louisiana

specialty chemical, polymer, and composite businesses: Syensqo. These operations have combined annual sales of \$8.5 billion. The company housing commodity chemicals—such as peroxides, silica, and Solvay's founding business, soda ash—will retain the Solvay name. These businesses have about \$6 billion in annual sales. In March, Solvay completed its exit from the polyvinyl chloride business when it sold its 50% stake in the RusVinyl joint venture in Russia to Sibur for \$450 million. The war in Ukraine put pressure on Solvay to divest the business, which generated sales of \$580 million in 2021.

30 Sumitomo Chemical

2022 chemical sales: \$16.9 billion

The Japanese company Sumitomo Chemical saw chemical operating profits decline by 51% in 2022. Management blamed a slow economic recovery in China, which was hit with a new round of COVID-19 restrictions, as well as tightening monetary policies around the world, which came at the expense of growth. Looking to the future, Sumitomo and FabricNano have been collaborating on enzymatic, cell-free manufacturing since 2021. They plan to move forward with commercial processes to make industrial chemicals, saying their method is more cost effective than fermentation and can compete with conventional chemical processes.

31 Toray Industries

2022 chemical sales: \$16.7 billion

Toray Industries made a breakthrough in the sustainable production of nylon last year when it unveiled what it calls the first biobased adipic acid, one of the raw materials for nylon 6,6. The Japanese company discovered microorganisms that produce adipic acid from sugar. It then used

genetic engineering to reconfigure metabolic pathways to increase the yield of adipic acid from the organism. The company hopes to go into production around 2030. In conventional polymers, Toray will expand capacity for polyphenylene sulfide in Kunsan, South Korea, by the end of 2024. And it is boosting the output of biaxially oriented polypropylene film in Ibaraki, Japan, to meet growing demand for capacitor film for electric vehicles.

32 Bayer

2022 chemical sales: \$15.1 billion

Bill Anderson, formerly with Roche and Genentech, took over from Werner Baumann as Bayer's CEO in June. Baumann's tenure was marked by controversy, as he was the architect of Bayer's acquisition of Monsanto, which came with big liabilities related to Roundup, Monsanto's brand of glyphosate herbicide. The German firm has meanwhile been getting creative about its agricultural pipeline. It is collaborating with Oerth Bio to use protein degradation technology to target proteins in weeds, insects, and crop diseases. And it acquired Targenomix, a spin-off from the Max Planck Institute of Molecular Plant Physiology that uses systems biology, omics technologies, precision phenotyping, and computational tools to identify new pesticide modes of action.

33 Mitsui Chemicals

2022 chemical sales: \$14.3 billion

Earlier this year, Mitsui Chemicals sold its Jurong Island, Singapore, phenol complex to competitor Ineos. The plant is relatively large, making 1 million metric tons per year of cumene, phenol, acetone, methylstyrene, and bisphenol A and generating annual sales of about \$750 million. Mitsui says it divested the commodity chemical business to mitigate earnings volatility, which has been a nuisance for many Japanese firms. Part of the path forward for Mitsui will likely be biobased feedstocks. The company has been loading vegetable and residual oils into its ethylene crackers for more than a year. And with Teijin, it is developing biomass-derived bisphenol A and polycarbonate.

34 Chevron Phillips Chemical

2022 chemical sales: \$14.2 billion

Chevron Phillips Chemical has added itself to the growing list of petrochemical makers that are interested in electric steam cracking. In June, the company formed a partnership with competitor LyondellBasell Industries and the engineering firm Technip Energies to develop Technip's version of the technology. Electric cracking uses electricity rather than gas-fired furnaces to generate the heat needed to crack hydrocarbon feedstocks. Powered by renewable energy, this new ethylene production method could potentially reduce the carbon dioxide emissions from ethylene production by 90%, the companies say. Chevron Phillips Chemical also has a pair of projects with QatarEnergy to build conventional ethylene steam crackers, one in Ra's Laffan, Qatar, and another in Orange, Texas.

35 Umicore

2022 chemical sales: \$13.2 billion

Umicore has been accelerating investment in battery materials. Last year, the Belgian catalyst maker unveiled plans to build a \$1.2 billion plant in Ontario for battery cathode materials and their precursors. It is also forming a joint venture with PowerCo, the battery business of the German automaker Volkswagen Group, to make cathode materials and precursors in Europe. The partners envision a \$2.9 billion investment. Umicore has also been betting on new technology. It is investing in the solid-state battery start-up Blue Current, and it is scaling up lithium manganese cathode materials.

36 DuPont

2022 chemical sales: \$13.0 billion

Late last year, DuPont concluded the \$11 billion sale of its engineering polymer business, a maker of nylon 6,6 and other resins, to Celanese. DuPont had aimed to use the proceeds to make acquisitions. But its \$5.2 billion purchase of the electronic materials maker Rogers was called off in November when the deal failed to win clearance from the Chinese government. In the meantime, DuPont has agreed to a smaller deal. It is buying Spectrum Plastics Group from the private equity firm AEA Investors for \$1.75 billion. Spectrum makes medical devices such as balloons, tubing, and catheters and has annual sales of about \$500 million. With the deal, about 10% of DuPont's sales will come from health care.

37 Air Products and Chemicals

2022 chemical sales: \$12.7 billion

Air Products and Chemicals has extended Seifi Ghasemi's term as chairman and CEO. The 78-year-old executive will now be able to serve until 2028. Already at the helm for 9 years, Ghasemi steered the US industrial gas maker in the direction of low-carbon hydrogen years before it became trendy among the company's chemical peers. Its signature project—a green ammonia complex in Saudi Arabia with Acwa Power and the special economic zone Neom—has secured financing. The \$8.4 billion enterprise, to be completed in 2026, will make hydrogen via renewable electricity-powered electrolysis. The complex will convert the H₂ into ammonia that will be shipped around the world for use as a transportation fuel. With the energy firm AES, Air Products is planning what it calls the biggest green hydrogen project in the US, at a cost of \$4 billion. In addition, Air Products is working on blue ammonia projects, which capture by-product carbon dioxide, in Alberta and Louisiana.

38 Arkema

2022 chemical sales: \$12.2 billion

Arkema continues to make small acquisitions that align with its existing businesses. For example, in June the French company announced it would purchase a majority stake in South Korea's PI Advanced Materials from Glenwood Private Equity for \$800 million. PI has annual sales of about \$220 million. It makes polyimide films for lithium-ion batteries, organic light-emitting diode displays, and other electronic applications. Arkema says the business fits with its high-end polymer unit, which makes materials like fluoropolymers and specialty polyamides. Last year, Arkema bought Polimeros Especiales, a Mexican firm that makes waterborne resins for paints and adhesives and has about \$40 million in sales. Arkema made a minor divestiture earlier this year when it sold its phosphorus derivatives business, which has \$30 million in annual sales, to the Belgian firm Prayon.

39 CF Industries Holdings

2022 chemical sales: \$11.2 billion

The US fertilizer maker CF Industries Holdings debuts in C&EN's Global Top 50 this year after missing previous-year rankings by a wide margin. CF made the cut because of a 71% surge in sales owing to high nitrogen fertilizer prices. The

world's largest ammonia producer aims to be a leader in clean ammonia. In April, it unveiled a project with NextEra Energy Resources to produce green ammonia at CF's plant in Verdigris, Oklahoma. The companies aim to install a 100 MW water electrolysis plant to make the required hydrogen. CF is also installing green ammonia at its flagship complex in Donaldsonville, Louisiana. CF is working on several projects for blue ammonia—made from natural gas with the sequestering and storage of by-product carbon dioxide—including ones with foreign partners, such as the Japanese firms Mitsui & Co. and Jera and South Korea's Lotte Chemical.

40 Westlake

2022 chemical sales: \$11.0 billion

The US petrochemical and chlorovinyl producer missed inclusion in C&EN's Global Top 50 ranking last year by less than

didn't come close to making the cut. What happened? A boom in lithium for electric vehicles, which has driven up prices and left lithium producers scrambling to add capacity as fast as they can. In 2022, SQM generated \$10.7 billion in sales, a 274% increase in just 1 year.

42 Resonac Holdings

2022 chemical sales: \$10.6 billion

Resonac Holdings launched on Jan. 1 of this year. It is a result of Showa Denko's \$9 billion purchase of Hitachi Chemical, a rare consolidation in the Japanese chemical sector. Resonac's largest business is in basic chemicals, such as olefins. Its second-largest business is semiconductor and electronic materials, which in 2022 was its most profitable one. These businesses are followed by operations in materials for lithium-ion batteries and specialty chemicals such as emulsion polymers and



\$200 million in annual sales. Thanks to a healthy 27% increase in sales, the company makes the list this year at a robust number 40. Westlake is a relatively young firm, founded in 1986. Over the years, it grew as a result of capital projects on the US Gulf Coast as well as acquisitions. It purchased Eastman Chemical's polyethylene business in 2006. It bought polyvinyl chloride rival Axiall in 2016. And in a move into specialty chemicals, it bought Hexion's epoxy resin business last year.

41 SQM

2022 chemical sales: \$10.7 billion

One wouldn't normally consider the Chilean inorganic chemical firm a candidate for the Global Top 50. In 2021, SQM had less than \$3 billion in sales and

unsaturated polyester resin.

43 Eastman Chemical

2022 chemical sales: \$10.6 billion

The big trend in plastics for the past several years has been chemical recycling. Eastman Chemical aims to become a leader in this field. It is spending \$2 billion to build three plants that will break down polyethylene terephthalate (PET) into its raw materials terephthalic acid and ethylene glycol. One, at its headquarters complex in Kingsport, Tennessee, will start up later this year. Eastman is also building a plant in France and a second one in the US. When used in soda bottles and other food packaging, PET has a relatively high recycling rate. But PET fibers and film don't lend themselves to the sorting, washing,

and melting of the mechanical recycling process. Eastman is betting that chemically breaking down that plastic will allow the industry to capture more PET for recycling.

44 Alpek

2023 chemical sales: \$10.6 billion

The Mexican polyester producer has returned to the Global Top 50 after a nearly 10-year absence. Like many firms that make polyethylene terephthalate (PET), the company saw a robust increase in sales—36%—because of higher prices in 2022. Over the years, Alpek has been a consolidator of the North American polyester industry, buying assets from DuPont, Eastman Chemical,

acid-based process to recycle carbon fiber.

45 ICL Group

2022 chemical sales: \$10.0 billion

The Israel-based inorganic chemical firm made the Global Top 50 for the first time in more than a decade after a 44% increase in sales in 2022. ICL is a major player in brominated chemicals, which are used largely as flame retardants. It extracts the bromine from the Dead Sea. But even larger than its bromine business are its potash and phosphate operations. In addition to phosphate fertilizers, ICL makes phosphorus-based chemicals for food and industrial applications. The company also

heat-resistant film for capacitors.

48 Sasol

2022 chemical sales: \$9.8 billion

A petrochemical project in Louisiana that went over budget by about \$4 billion was a major scandal for the South African energy and chemical firm a few years ago, but now Sasol appears to be turning the page. The company is considering decarbonizing that complex, in Lake Charles, Louisiana, through carbon capture and other strategies. For its massive site in Secunda, South Africa, Sasol and its industrial gas partner Air Liquide plan to buy renewable electricity from a wind project planned for the country's Eastern Cape. The energy would power the air separation units that provide the site with oxygen. Additionally, Sasol recently opened a \$39 million analytics laboratory in Brunsbüttel, Germany.

49 OCI

2022 chemical sales: \$9.7 billion

The Dutch methanol and nitrogen fertilizer maker OCI debuts in the Global Top 50 this year. OCI has been growing steadily in recent years, and in 2019 it merged its fertilizer operations with those of Abu Dhabi National Oil Company. Like many nitrogen fertilizer firms, OCI is planning to make low-carbon ammonia in the US. It is partnering with the industrial gas supplier Linde on a project in Beaumont, Texas. Linde will build the autothermal reformer and manage carbon capture. OCI will build the ammonia plant, which will start up in 2025. The company also makes biomethanol out of methane captured from decomposing waste. The company wants to develop a market for such low-carbon methanol as a fuel for ships and barges.



OCI wants to market low-carbon methanol as a fuel for ships and barges.

and Wellman. It is working on building a large PET joint venture with Indorama Ventures and Far Eastern New Century in Corpus Christi, Texas, by 2025.

45 Asahi Kasei

2022 chemical sales: \$10.0 billion

A big part of Asahi Kasei's strategy recently has been working with outside partners to develop new technologies. It recently started a venture capital fund with a budget of \$100 million. The Japanese firm set up the fund in Silicon Valley, where it hopes to find start-ups with technologies in hydrogen, energy storage, and biobased chemicals. In Japan, Asahi Kasei is working with Microwave Chemical to develop a recycling process that breaks down nylon 6,6 into its raw materials, hexamethylenediamine and adipic acid. It has also been working with the National Institute of Technology at Kitakyushu College and the Tokyo University of Science on a sulfuric

plans to build a plant in Saint Louis, Missouri, for lithium iron phosphate used in electric vehicle battery cathodes.

47 Borealis

2022 chemical sales: \$9.8 billion

Borealis intends to make 600,000 metric tons per year of plastics from recycled and recovered raw materials by 2025. To that end, the Austrian firm has been acquiring existing recyclers. In June, it agreed to purchase the Italian polypropylene recycler Rialti. At the beginning of this year, it purchased a controlling stake in Renasci, which operates a pyrolysis plant in Belgium that breaks down waste plastics into petrochemical raw materials. Borealis has also been innovating in polymers. Working with the cycloolefinic copolymer producer Topas Advanced Polymers, it developed the copolymer ethylene-propylene-norbornene. Launched under the name Stelora, the polymer will first be marketed as a

50 PTT Global Chemical

2022 chemical sales: \$9.7 billion

The US petrochemical industry saw a construction boom on the Gulf Coast in the 2010s. Some firms aimed to build a second cluster of plants in the Appalachian region, close to vast shale gas resources. PTT Global Chemical was one of those firms, choosing Ohio for an ethylene and polyethylene complex. Those plans appear to be on hold, but the Thai chemical maker hasn't been idle. In 2021, it bought the coating resin maker Allnex from the private equity firm Advent International for \$4.8 billion. PTT also invested in the start-up Boston Materials, which reclaims carbon fiber. ■