Driving toward the future of materials

Considerations for Europe and the chemical industry

Companies in the materials industry—including those in chemicals—have long played an important role in the daily lives of people around the globe. But as a changing world brings new challenges—from global competition to disruption and the growing need for sustainability—the industry is often seen as mature and largely static, with limited involvement in meeting those challenges. In reality, however, it is on the verge of a new era. The future of materials will play a vital role in reshaping our "material world" for the betterment of people and the planet.

Today, the industry is seeing the creation of a range of new materials in a revolution that is driven by technology-enabled innovation, coupled with increasingly sophisticated end uses and products that require materials with new properties. Many of these materials would have sounded like science fiction just a few years ago. They include self-healing materials that can recover from scratches and cracks; metal foams that are lighter than traditional metals while providing the same strength; and willow glass that is strong, lightweight and conformable, and can be used in ultra-thin displays and flexible solar cells.

This growing range of new products is likely to drive the next wave of growth for the materials industry, according to an Accenture analysis. For European chemical companies in particular, it will bring opportunities to adopt new business models and compete more effectively in global markets. To succeed, however, they will need to rethink their value chains, find ways to expand manufacturing capabilities and capacity in the region, and take advantage of digitally powered approaches to faster, more focused innovation.

There are certainly challenges ahead, but the opportunity is tremendous. Ultimately, the revolution in materials has the potential to transform the industry, and in turn empower it to help address some of the world's most fundamental issues, from providing affordable green energy to the elimination of hunger and making clean water available to all.

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New materials, new opportunities

The flow of new materials coming to market promises to create new possibilities for companies across sectors, and it will ultimately reshape many end markets. For example, the use of stronger and self-healing coatings on vehicles will have a significant impact on local auto repair markets across Europe and the globe. Or the use of carbon-fiber enforced concrete, which is lighter and has greater load-bearing capacity than traditional concrete, is already bringing more flexibility to the design of building projects.

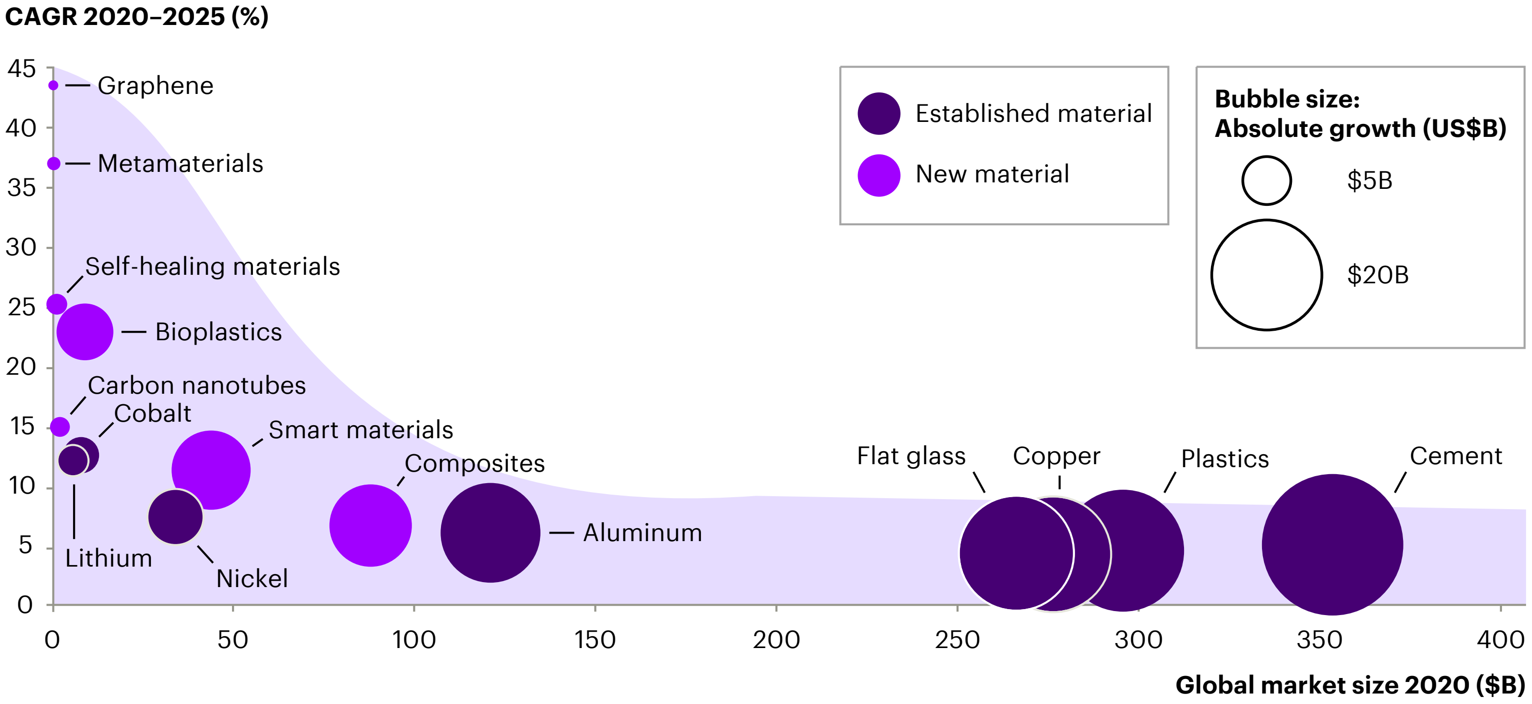
These and other new materials will open the door to new sources of growth for chemicals and other materials manufacturers. New materials will also reshape existing consumption patterns. Globally, the world uses an estimated 542 kilograms (kg) of cement, 245kg of steel, 36kg of plastic and 31kg of cardboard on a per-capita basis.[1]

However, innovative advanced materials will enable new uses and create new markets, and will thus provide new drivers of growth. Growth rates are expected to be higher than those of traditional materials in the coming years (Figure 1)—creating an estimated US$150 billion growth opportunity by 2025.

A number of fundamental trends are driving this growth, such as the increasing focus on affordable and clean energy, good health and well-being, and other United Nations Sustainable Development Goals (SDGs).[2] Overall, the innovative advanced materials now in place or being developed support and directly contribute to meeting many of the SDGs. One of those goals, for example, is "clean water and sanitation."

Here, metal-organic frameworks can be used to extract water from desert air; graphite-oxide sieves can help with desalination of salt water; and nanosilver paper can provide affordable water filtration.

Figure 1: Projected growth of established and new materials



Source: Accenture Research, BCC Research, Grand View Research, MarketsandMarkets, ICIS. Steel market calculated based on an assumed average steel price of US$1,000/metric ton.

Efforts to meet another goal, "life below water," could draw on nanocarbon springs to decompose microplastics, or UV-reactive nanocoatings to break down microplastics.

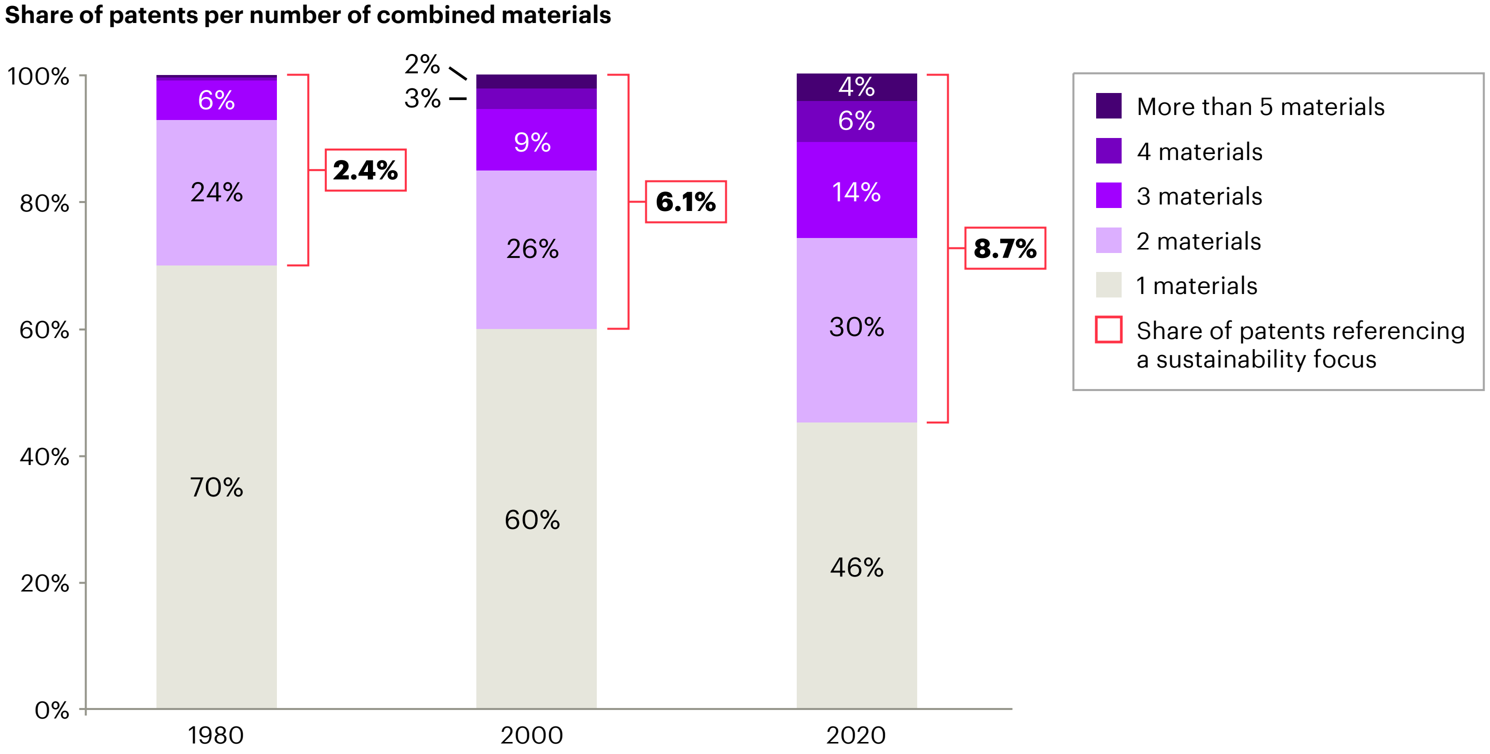
New opportunities and growth are also linked to fundamental changes in the materials markets across three key dimensions: *the convergence of material classes; the convergence of material and digital properties; and a shift to smarter, more sustainable materials.*

Convergence of material classes

Accenture analysis of patent filings over the last four decades shows that innovation in materials has involved the increased convergence of material classes—that is, patents for materials have tended to cite more than one material. In 1980, 70% of materials patents cited just one material, and 6% cited three or more; by 2020, just 46% cited one material, and 24% cited three or more. (Figure 2)

Typically, patented solutions that combine material classes have been regarded as more difficult to recycle and less sustainable. And yet the share of multi-material patents citing enhanced sustainability properties has actually risen from 2.4% to 8.7% during this same 1980 to 2020 period—an indication of the growing connection between sustainability and innovative materials.

Figure 2: Increasing multi-material patents



Source: Accenture Research analysis of global patent landscape, including 160,000+ priority filings for selected 10 material groups; based on DerwentInnovation™, Clarivate © 2022, company and institute filings only, excluding utility model. Search for sustainability focus included terms such as: recycle, circular economy, renewable, biodegradable, biomaterials, green materials, CO2 footprint, decarbonization and sustainable.

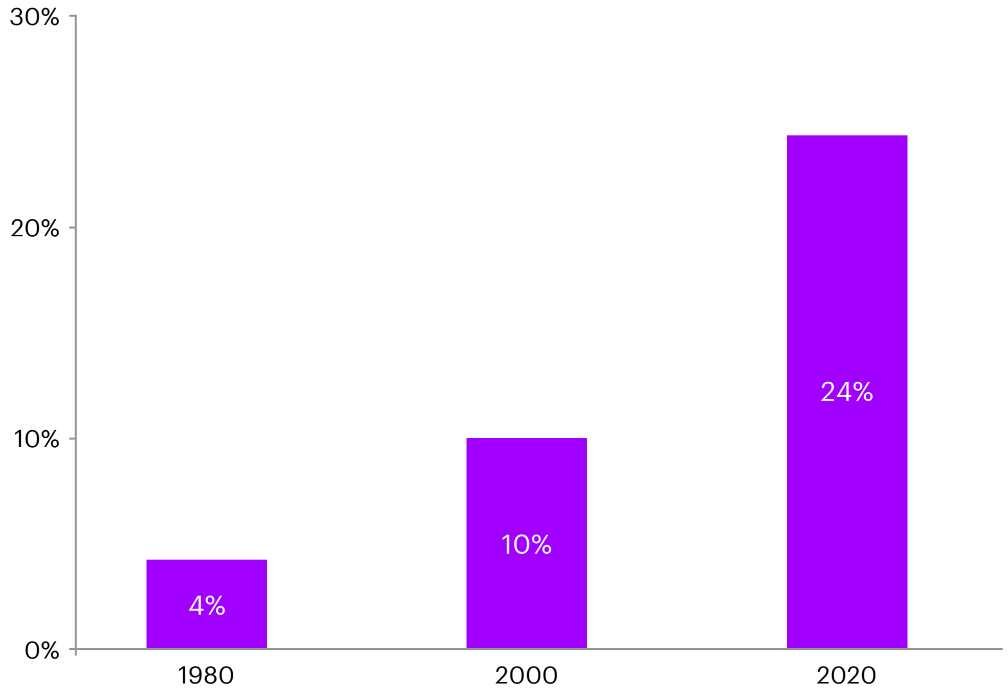
Convergence of material and digital properties

Traditionally, innovation in materials focused on optimizing properties such as heat resistance, tensile strength, elasticity or resistance to corrosion. However, Accenture's patent analysis shows a new pattern—an increase in patents for materials that have digital and smart properties. In 2020, for example, 24% of patents refer to the digital and smart characteristics of a material versus 4% in 1980, indicating increased convergence of material and digital properties. (Figure 3)

This increasing convergence means that chemical and other materials companies need to build new capabilities to handle, deploy and use digital and smart materials. Some of these capabilities can be built in-house, while others will require the development of new partnerships and new ways of going to market.

Figure 3: Increasing multi-material patents with digital properties

Share of patents with two or more materials and referencing a digital and smart focus



Source: Accenture Research analysis of global patent landscape, including 160,000+ priority filings for selected 10 material groups; based on DerwentInnovation™, Clarivate © 2022, company and institute filings only, excluding utility model. Search for digital and smart focus included terms such as: nano, memory, quantum, self-, metamaterial, piezo, dielectric, sensitive and 4D printing.

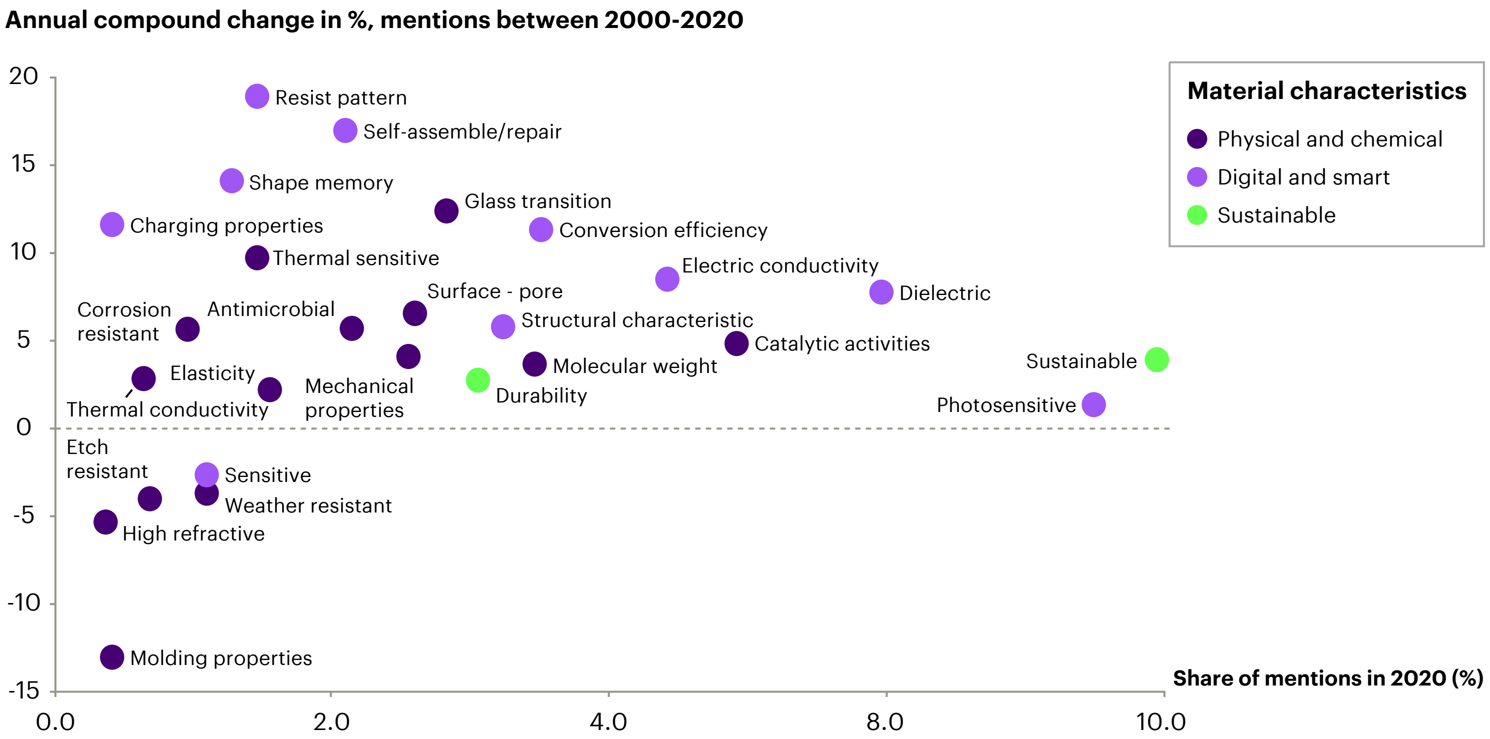
Shift to smarter, more sustainable materials

Innovative materials offer a range of new properties, with a growing focus on smarter and more sustainable qualities, according to Accenture's patent analysis. (Figure 4) Smart materials include those that can change properties when prompted by an external stimulus. For example, shape-memory polymers can be deformed and then returned to their original shape in a controlled fashion using light, electricity or other stimuli—and one, vanadium oxide, "remembers" its exposure to such stimuli, allowing it to respond more quickly to later exposures.

Sustainability is also a key aspect of many new materials, and a driver of growth in its own right. For example, flexible solar panels and perovskite solar cells that are twice as efficient as traditional solar cells could lead to the increased use of renewable energy, with the potential to bring a significant amount of additional solar energy to Europe.

And wooden "mass timber" skyscrapers represent a new approach that is based on green building materials, providing structural stability and reducing buildings' need for cement, a material with relatively high greenhouse gas (GHG) emissions, by roughly 30%. Such buildings could also create opportunities for the chemical industry to provide new protective coatings and wood-bonding solutions.

Figure 4: Increasing focus on smart, sustainable characteristics



Source: Accenture Research analysis of global patent landscape, including 160,000+ priority filings for selected 10 material groups; based on DerwentInnovation™, Clarivate © 2022, company and institute filings only, excluding utility model. Quid text analysis executed on abstracts of new material filings to identify property characteristics that offer an "advantage."

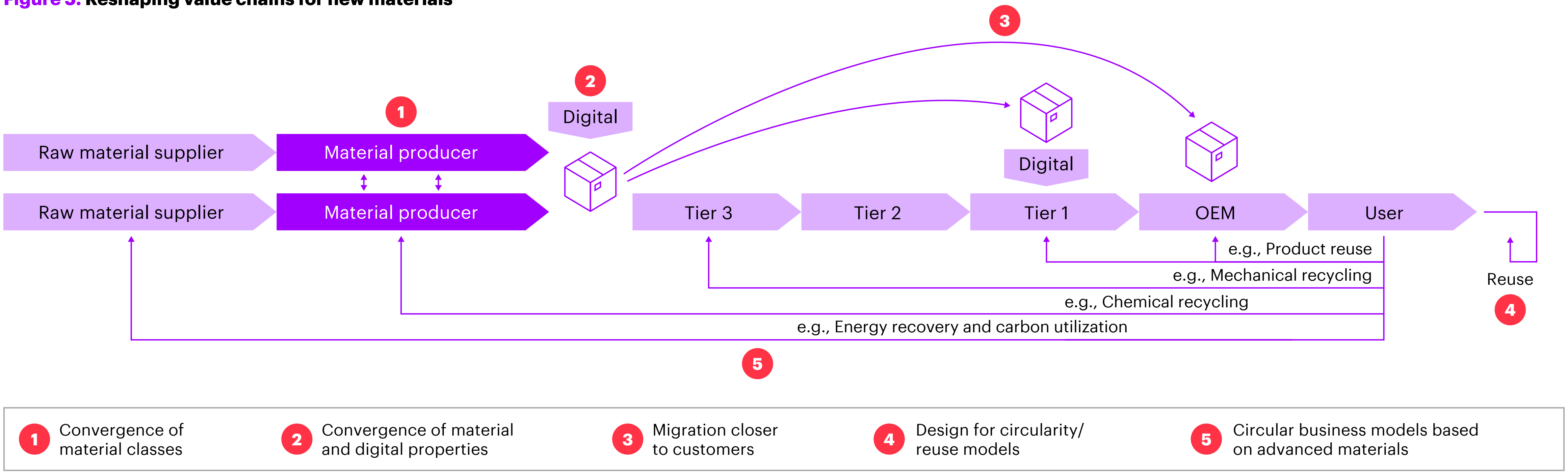
New business models

The effective creation, production and delivery of new materials will require change, not only in the materials sector itself, but across industries—and it will call for the reshaping and reinvention of value chains.

A significant amount of development and marketing will need to move closer to end customers to drive and accelerate innovation, reshaping and disrupting existing value chains, such as the traditional structure of an original equipment manufacturer (OEM) and sequential Tier 1, 2 and 3 suppliers. (Figure 5)

And the growing emphasis on circularity will create opportunities for companies to adopt new business models that use new materials to enable more reuse, mechanical and chemical recycling, and energy recovery and carbon utilization. Altogether, the reshaping of value chains will provide another avenue for competition and growth.

Figure 5: Reshaping value chains for new materials



Source: Accenture analysis and project experience.

How change will happen

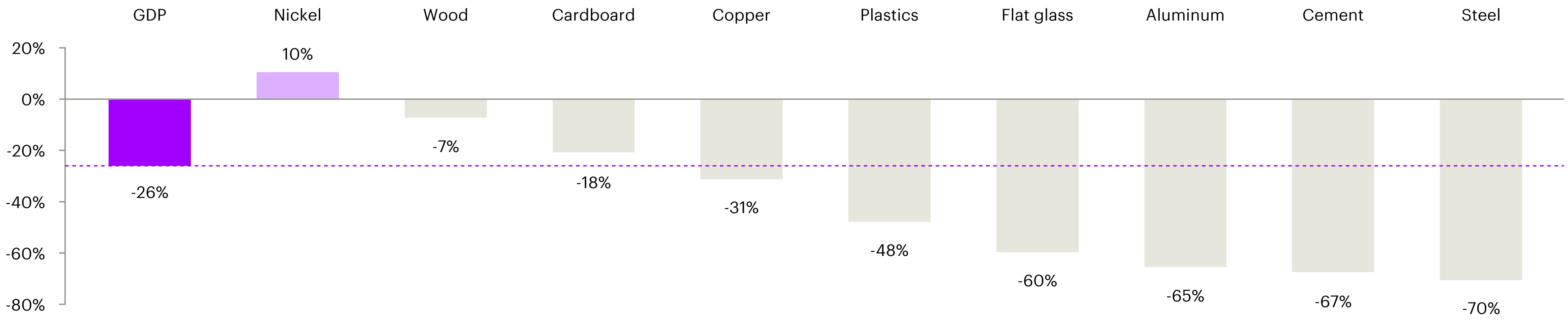
The materials revolution offers a bright future. However, innovation is often based on additional developments of existing materials, which means it relies largely on existing production capabilities—and for European chemical and other materials companies, that presents a challenge.

Over the last two decades across almost all material classes, Europe's share of global markets has declined (Figure 6)—much of this being lost to China. This is not just a result of having a reduced share of global GDP: In many materials categories, reductions in market share have significantly outpaced the loss of GDP share.

For example, the European share of steel and cement has declined 70% and 67%, respectively, compared to a 26% drop of GDP share. This indicates that Europe could find itself with relatively less manufacturing capacity to draw on in the race to take advantage of innovative materials.

Figure 6: European share of global materials markets

% change in global market share of EU material producers, 2020 vs. 2000 (2000 share index=100)

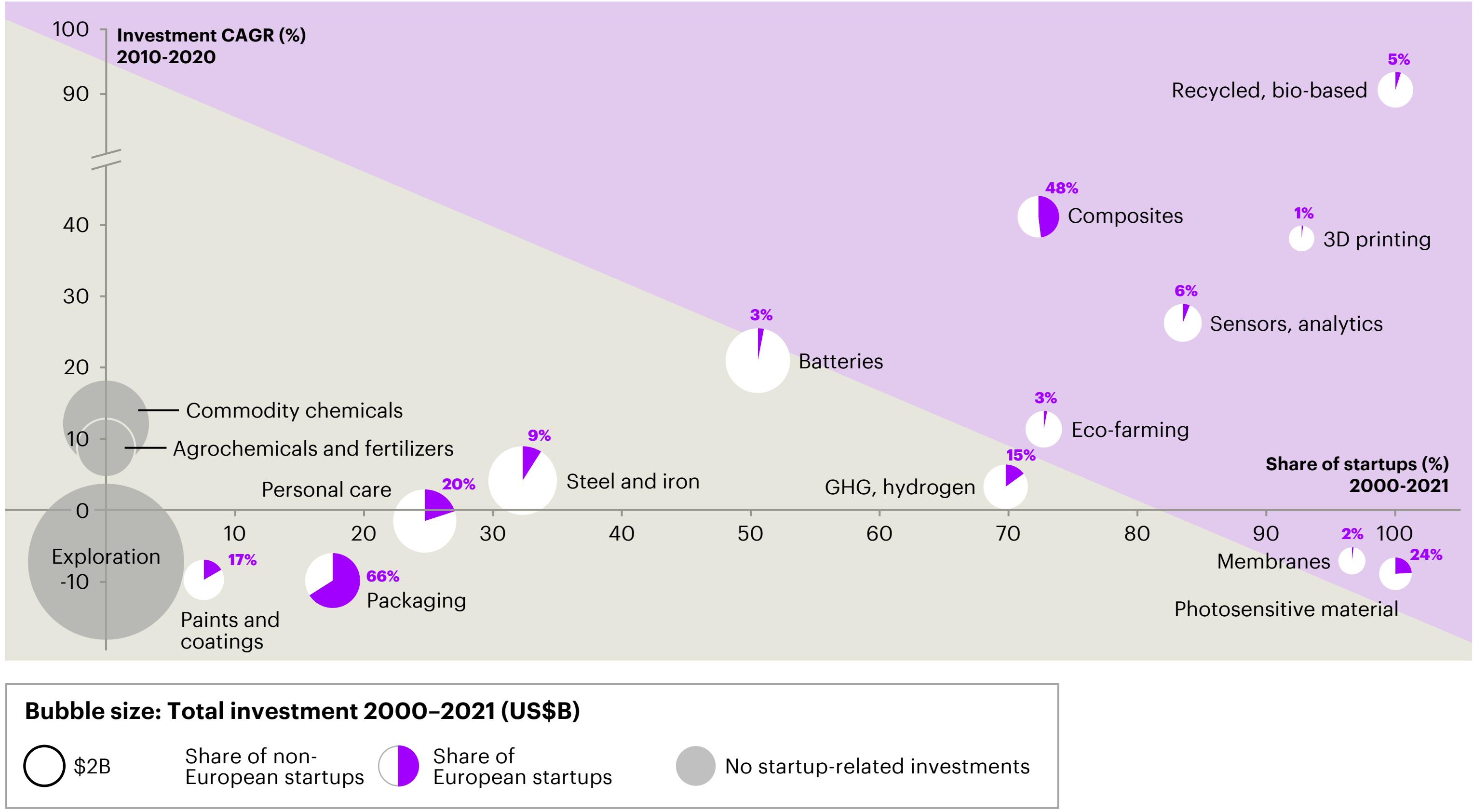


Source: Accenture Research, United States Geological Survey (USGS), CEMBUREAU, ICIS, Statista, GEA, Fastmarkets RISI, World Mining Data, Oxford Economics – Real GDP (2015 prices in US$ billions). Europe is referred to as EU-28; minerals such as nickel and copper are based on mined production numbers.

On the other hand, the industry in Europe can benefit from some positive factors. Globally, the new materials landscape is still emerging and in flux, with startups playing a significant role in its development. (Figure 7) Europe has a sizable base of such startups, which have brought investments in fields such as composites, bio-based materials and sensors. These startups represent a growing pool of talent, knowledge and capabilities, and the industry has an opportunity to collaborate with and tap into that pool to advance innovation. That means that companies and governments should work to provide environments that foster startups in order to strengthen the region's new materials business.

At the same time, European companies can draw on today's increasingly powerful "science technology" (science tech) to improve innovation efforts. Science tech builds on and combines cloud, data, analytics, artificial intelligence and automation to allow virtual rather than physical experimentation with new materials, bringing greater speed and better targeting to innovation. An Accenture analysis of priority patents shows that filings based on "traditional" approaches in fields such as steel, cement, glass and so forth declined or grew only slightly in the past few years. At the same time, those involving disruptive innovations derived through computational chemistry—a type of science tech—had a notable increase.

Figure 7: Startups and innovative materials



Source: Accenture Research analysis based on S&P Capital IQ Pro. More than 2000 material companies incorporated since 2000 with status of: operating, operating subsidiary, acquired, completed investment as listed. Total sum of investments for 2000-2021 was US$103 billion; investment coverage includes: equity capital markets, debt capital markets; rounds of funding.

Taking the next steps

To make the shift to the next generation of materials, the industry, companies and governments all need to make innovation in materials a priority, and pursue several key actions:

- Expand funding for corporate innovation and startups in materials.
- Provide funds for the large-scale transformation of industrial assets and plants to support both GHG reductions and innovation in materials.
- Set up frameworks, structures and ecosystems that support collaboration and capabilities focused on the convergence of material classes and of material and digital worlds.
- Invest in building new skills, talent, innovators and entrepreneurs with a focus on new materials.

The opportunity is simply too big to ignore. The materials revolution will not only provide new products to bring to market, it will also change the competitive landscape by allowing European chemical and other materials companies to compete on innovation, rather than just costs. It will enable the sector to play a vital role in increasing sustainability and building the circular economy. And it will allow companies in Europe to keep uncovering new ways to win in global markets.

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References

1 Accenture Research analysis of consumption-based global production volumes estimated for 2020. Data sources include: Wood Mackenzie, Fastmarkets RISI, CemNet, International Commission on Glass, United States Geological Survey (USGS), Oxford Economics, Statista and World Bank. For lithium, nickel, cobalt and copper only, mine-based/virgin material is assumed. Glass includes flat glass, containers and domestic glass. Some of the numbers were precise; others were rounded.

2 United Nations, The 17 Sustainable Development Goals, https://sdgs.un.org/goals.

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