



Market Update for the Advanced Materials Sector

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The importance of the advanced materials sector

Advances in materials are a driving force in human civilization. Historical eras were so impacted by these developments, that we now refer to periods such as the Iron Age by their material discoveries. Even today's innovations in software and computing are underpinned by the materials that enable these technologies. The Energy Materials Industrial Research Initiative, an industry-driven clean energy association, estimates that 70% of technical innovations across all sectors are directly or indirectly attributed to advanced materials. Realising the importance of advanced materials, companies such as AXT have described themselves as “a materials science company”, rather than a producer of semiconductor wafers.

Despite their importance, it can be tempting to focus on the applications and end-markets for advanced materials while understating the unique dynamics that shape the sector. At Future Materials Group (FMG), we believe the advanced materials market possesses unique properties that warrant special coverage. Competing in this sector is complex. Advanced materials value chains are often long, fragmented and opaque. R&D-intensive development and adoption cycles are often measured in decades. However, in

part due to these barriers to entry, the sector can offer outsized returns, with advanced materials companies trading at a premium to more commoditised materials and chemicals firms. A better understanding of this sector is therefore critical, given the enabling role that advanced materials have in their end-markets.

FMG was created to assist industry players meet their growth objectives by helping them navigate the complex landscape of advanced materials value chains – in particular, offering services in growth strategy and M&A advisory. This report, updated twice a year, offers a glimpse into the forces shaping the sector. Our Market Dynamics section (see page 3) examines the trends shaping the sector and key end-markets that utilise advanced materials. Leveraging FMG's database of advanced materials companies, our Financial Review section (see page 7) assesses financial trends in the industry that impact corporate strategy.

Looking ahead, FMG believes that advanced materials can be part of the solution to many of the world's key future challenges: sustainability, resource scarcity, demographic changes, advances in healthcare, energy security and Industry 4.0. Meeting these needs requires not just engineering and research expertise, but sound investment and market knowledge. With this in mind, FMG will continue to closely monitor the market trends and opportunities in each update to follow.



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Defining the advanced materials sector

Creating a concise yet meaningful industry segmentation is a challenging task. Advanced materials, in particular, can have different definitions to different observers which can shift over time.

At FMG, we prefer a broad definition of advanced materials that captures a variety of technologies. In general, advanced materials tend to have the following properties:

*Advanced materials possess **intrinsic properties** that offer an advantage to the end-product or to the manufacturing process*

*Advanced materials are often **highly differentiated** and contain considerable intellectual property*

*The advanced materials market is often restricted by **high barriers to entry** created by complex processes and technical expertise*

The above criteria capture a breadth of advanced materials, ranging from spherical metal powders for the additive manufacturing industry to specialised flavour additives for the nutrition industry. We can further analyse this sector and derive insight by applying a variety of lenses, such as exploring the underlying chemistry of the material, the functionality the material offers, the position in the value chain and the end-

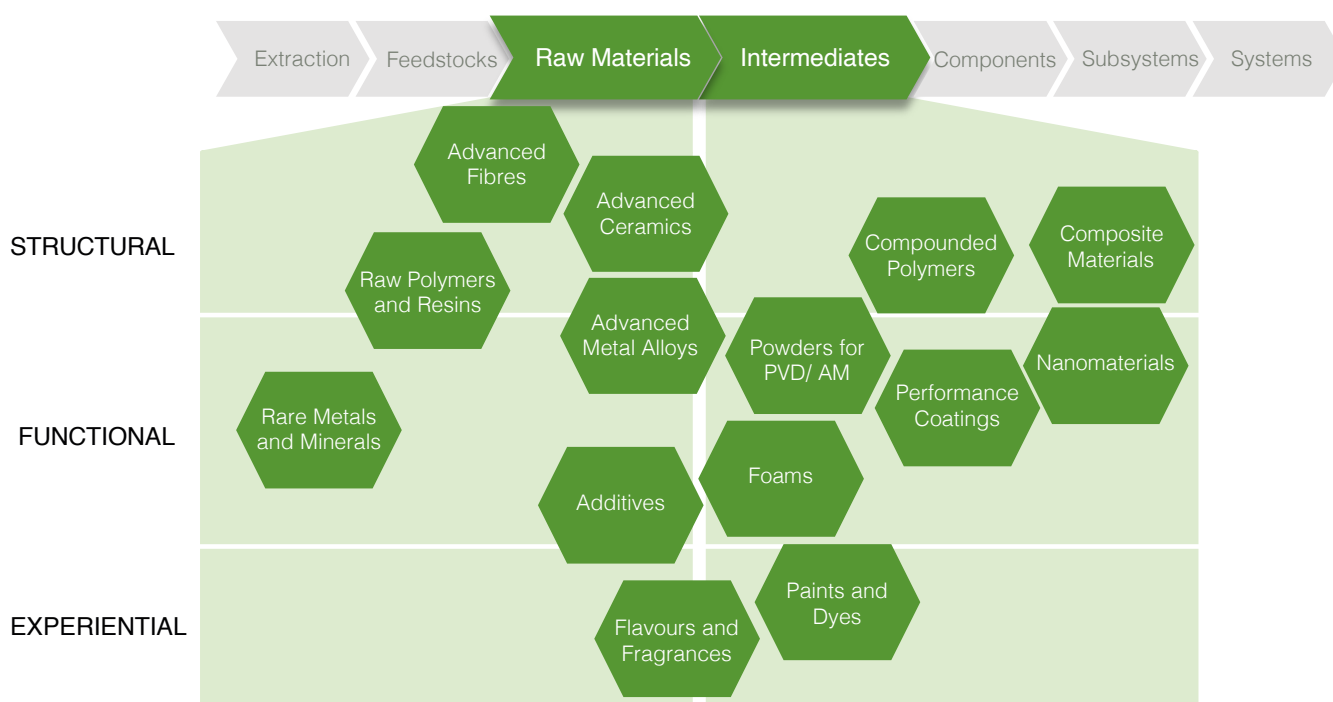
market it serves. These lenses provide insight into how companies develop their strategies and how investors value them.

When analysing the market in this manner, several commonalities emerge among advanced material companies. First, these companies can often derive higher margins and are less asset intensive than their commodity chemical counterparts. As a result, advanced materials companies are typically traded at a premium in financial markets. Finally, given the long development cycles for advanced materials, many companies use acquisitions to drive innovation and protect against commoditisation.

To monitor financial metrics within the industry, FMG has created a database of approximately 150 publicly traded companies which helps quantify and analyse financial trends. As our focus lies with materials producers, we focus on raw material and intermediates producers, rather than upstream feedstock suppliers and downstream component manufacturers. The companies selected all have commercial production capacity as opposed to pure R&D firms. The chart below shows a small selection of different materials and functionality within our focus area of the value chain.

Any definition of the advanced materials market is inherently dynamic as material technologies evolve over time. As some materials may shift towards commoditisation, new materials are constantly being engineered. Consequently, FMG's definition and analysis will continue to evolve with the industry.

■ Landscape of select advanced materials



Market Dynamics

Post-pandemic acceleration in portfolio transformation activity

In August 2021, Ashland signed an agreement to sell their performance adhesives business to Arkema in a USD 1.65 billion deal. Ashland stated in their press release that they “will be a focused additive and ingredients company with leadership positions in life sciences, personal care and coating.” In a similar vein, Arkema described the acquisition as being “perfectly aligned with the Group’s ambition to become a pure Specialty Materials player by 2024.”

The post-pandemic environment has seen many companies re-evaluate their strategies. For many, this has led to acquisition and divestment activity as companies seek to adjust their portfolio of businesses and technologies to changes in the market. While these adjustments are relatively common, the pandemic has created a surge in portfolio transformation activity. Across all industries, JP Morgan recently reported a record USD 3 trillion in spin-off and split-off activity across all industries in 2021.

For advanced materials, two strategies have tended to dominate the acquisition and divestment activity: capability focussing and portfolio rebalancing. In capability focusing, a relatively diversified player re-aligns their portfolio around a particular end-market or technology. In doing so, the company aims to redefine themselves to both customers and the investment community. In portfolio rebalancing, a company seeks out new high-growth markets or product lines while divesting underperforming units.

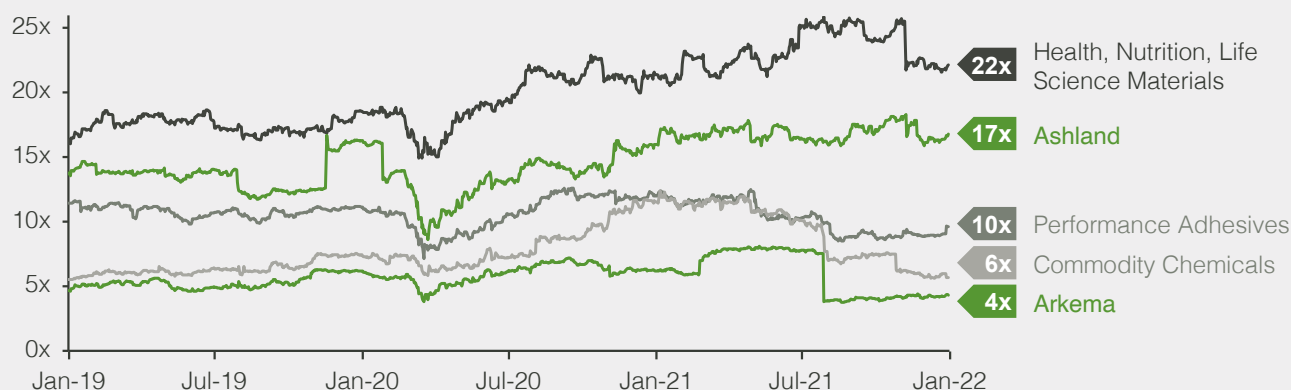
For Ashland, the divestment of the performance adhesives business allows the company to focus on their additives business in the health, nutrition and life science sector. As shown in the chart below, advanced materials companies operating in this sector have seen a valuation increase due to the robust margins and relatively low cyclical nature. By divesting non-core businesses and refocussing on this area, Ashland may be able to achieve the same valuation levels as their peers. For Arkema, the acquisition of performance adhesives also has the potential to shift the company towards a higher valuation multiple.

In contrast to capability focussing, companies pursuing portfolio rebalancing often seek to diversify into more attractive markets. These firms seek not just higher growth, but aim to build greater flexibility and resilience into their business. Lanxess, which underwent several acquisitions and divestments in 2021, stated in their annual report “in recent years, we have made our portfolio much more balanced and resilient through both focused acquisitions in promising growth sectors and disposals of business units with below-average performance.”

Several factors have driven advanced materials companies to rebalance their portfolios. Supply chains have been reorganised since the beginning of the pandemic, creating both opportunities and threats for material producers. Prices for commodity chemicals, which often serve as feedstocks for advanced materials, have increased significantly in the past twelve months (see chart on next page). COVID-induced lockdowns increased demand for certain products while lowering the demand for others. Materials companies will be

Valuation multiples

EV/EBITDA (LTM) multiple

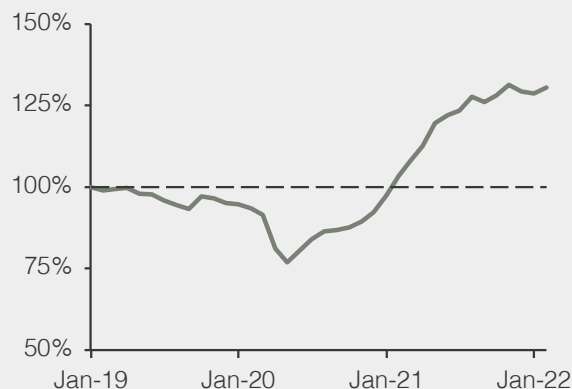


Source: Koyfin, FMG Analysis

seeking industries that can tolerate higher prices and remain less susceptible to the current business cycle.

Raw material prices

Producer Price Index: Industrial Chemicals



Source: US Federal Reserve Economic Data

For companies seeking to transform their portfolio, market conditions present new opportunities for carve-outs along with a pool of potential buyers for divestments. At the same time, companies should remain aware of the competition for potential acquisitions, not just from strategic buyers but also from private equity firms (see page 10). Companies that can best exploit these opportunities will have a well-defined inorganic growth strategy and a robust methodology for evaluating potential deals.

Additive manufacturing sees a surge in public listings

In 2021, additive manufacturing (AM) companies stepped into capital markets in force. Throughout the year, FMG tracked nearly a dozen pure-play additive manufacturing listings, either through an initial public offering (IPO) or through a special purpose acquisition

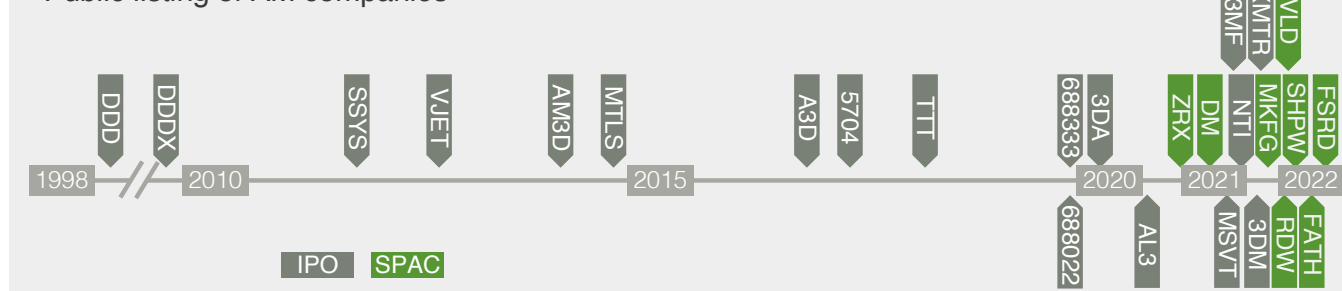
company (SPAC). As shown in the chart below, the number of entrants far surpassed what was seen in prior years.

AM and 3D printing technology have advanced rapidly over the last two decades, as have the number of companies in this sector. An expiring of legacy patents in the mid-2000s and early 2010s led to an explosion of 3D printer manufacturers and service providers over the last decade; the patent of fused deposition modelling – a technology widely used in hobbyist printers – expired in 2009. Most public AM companies, however, cater to industrial customers rather than consumer markets. Stratasys (SSYS) and 3D Systems (DDD), the dominant players in the industrial sector for the last three decades, are now joined on the stock markets by companies such as Velo3D (VLD), Xometry (XMTR), MarkForged (MKFG) and Desktop Metal (DM).

The step into the capital markets for these newly listed companies was followed by an unfortunate stumble. As the chart on the next page shows, valuations for the new entrants fell in the latter half of the year and most were trading below their IPO values by year-end. The drop in valuations had several causes. Tech stocks, in general, performed worse than the market towards the end of the year. Many of the AM companies entered the market through SPACs, and a SPAC sell-off in October adversely affected these companies. Even with these effects, AM stock valuations were uncharacteristically high at the beginning of 2021. Stock market incumbents such as Stratasys and 3D Systems had seen a rapid spike in January and February, and the subsequent drop could be seen as a return to more normal valuation ranges. This drop appeared to also drag down some of the newly listed companies.

Shrinking valuations will put pressure on these companies to show investors that their future growth plans are achievable. A common strategy among these newly listed companies is to develop an end-to-end platform of software, machinery, and materials, rather than focussing on any single aspect of the value chain.

Public listing of AM companies



Not only does the end-to-end solution simplify the design and manufacturing process for the customer, but it also begets more data which the company can use to further improve their software and machinery. This feedback loop incentivises companies to increase market share as more customers yield ever more data.

Not all companies, however, have adopted this end-to-end strategy, and some are vying for a more open marketplace. Shapeways, which listed in October, creates material- and hardware-agnostic software that is compatible with a variety of manufacturers. These business models provide customers greater flexibility to choose hardware and materials, rather than restricting them to a single platform. For the platform providers, this could present a threat to customer lock-in and lower the entry barriers for new entrants. Should the market become less vertically integrated, industry players will need to find new ways to differentiate themselves from competitors. Several have focused on their IP portfolios, such as offering unique and advanced materials. Composites, for example, appears frequently in IPO presentations as an area of focus.

Regardless of which strategy prevails, market forces are likely to drive further M&A activity in the sector – either for companies building market share for their platform or capturing valuable IP. Desktop Metal, for example, acquired six companies in 2021, and other companies appear to be ramping up their acquisition activity. Successful companies in this space will need to understand how to evaluate the potential of IP and how to rapidly incorporate these acquisitions into their solutions.

Incumbent listed AM companies

Dividend adjusted stock performance

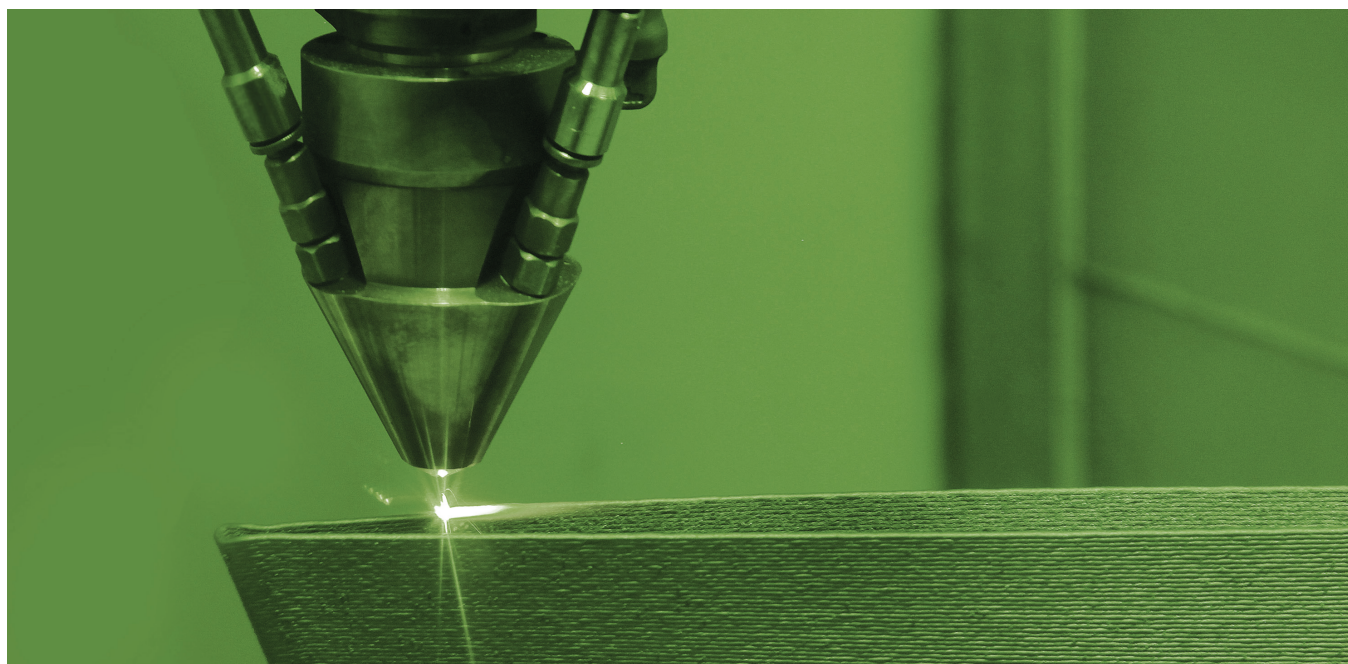


Newly listed AM companies

Dividend adjusted stock performance



Source: Koyfin



Financial Review

Profitability remains stable despite cost and supply chain issues

Like many sectors of the economy, advanced materials companies continue to face higher input costs and supply chain disruption. Increased demand for physical goods, material shortages, increased freight costs (see chart) and the conflict in Ukraine have driven prices for materials higher. Carbon fibre prices, for example, traded around 15% above pre-pandemic levels due to high demand and a resulting material shortage. The recent rise in oil and energy prices will increase this further.

As a result of higher prices, commodity chemical companies have enjoyed increased profits throughout this period. The chart below shows a sharp rebound in earnings before interest and taxes (EBIT) for commodity chemical firms after the initial drop in profitability during lockdown periods.

Global shipping prices

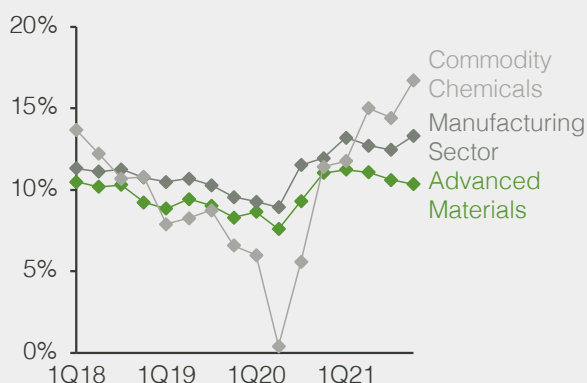
Freightos Baltic Global Container Index (FBX)



Source: Freightos

Sector Profitability

EBIT Margins (seasonally adjusted)



Source: Koyfin, Pitchbook, FMG Analysis

EBIT levels for advanced materials companies have remained resilient to the impacts of the pandemic and have returned to 2018 levels. Many firms in the sector have been able to pass on higher raw material input prices to their customers, particularly in situations where all producers are affected by the same rising commodity prices. As advanced material firms tend to be less asset intensive than their commodity chemical counterparts, a drop in utilisation levels tends to have a smaller effect on profitability levels.

The pandemic recovery combined with global geopolitical uncertainty may continue to drive higher input prices and supply chain disruption throughout 2022. This will continue to put pressure on advanced materials firms to manage their supplier base to adapt to the changing market landscape. Disruption will continue to create challenges for firms, but some may be able to find opportunities in the fluctuating market. By way of example, some manufacturing companies will be willing to pay more for local suppliers and shorter supply chains, presenting advanced material suppliers with new opportunities.

Valuation multiples fall towards year-end, but remain above pre-pandemic levels

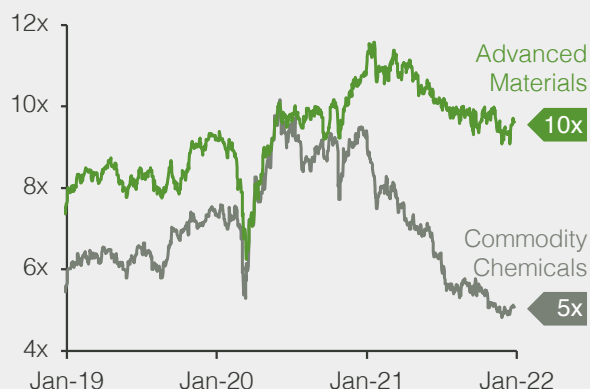
Valuation multiples for advanced materials firms were lower at the end of 2021 than at the start, but still remain above pre-pandemic levels. The chart on the next page shows the ratio of enterprise value (EV) to earnings before interest, tax, depreciation and amortisation (EBITDA). To account for the impact of COVID-19 on EBITDA levels, FMG tracks forward-looking multiples using analyst estimates for EBITDA levels over the next twelve months. In 2021, EV/EBITDA multiples across the advanced materials sector ended the year at 9.6x, up from just under 8x at the start of 2019 but down from a peak of near 11x at the start of the year.

Changes in valuation multiples can be caused by fluctuations in both value and EBITDA. The drop throughout the year is largely due to falls in valuation rather than changes in EBITDA; as a cohort, forward-looking EBITDA levels were relatively flat or slightly up from the start of 2021.

Advanced materials can be seen to have fared better than commodity chemicals companies from a valuation

Valuation multiples

Median EV / EBITDA (NTM) multiples



Source: Koyfin, FMG Analysis

perspective. Many commodity chemicals companies saw considerable improvements in EBITDA levels in recent months due to higher prices. However, these gains have not been reflected in higher valuations, resulting in a lower multiple. The fact that higher EBITDA levels are not translating to higher valuations reflects a general discount that investors are giving to cyclical

industries. This could indicate that today's higher commodity prices are viewed as a transient effect and not a long-term source of value creation.

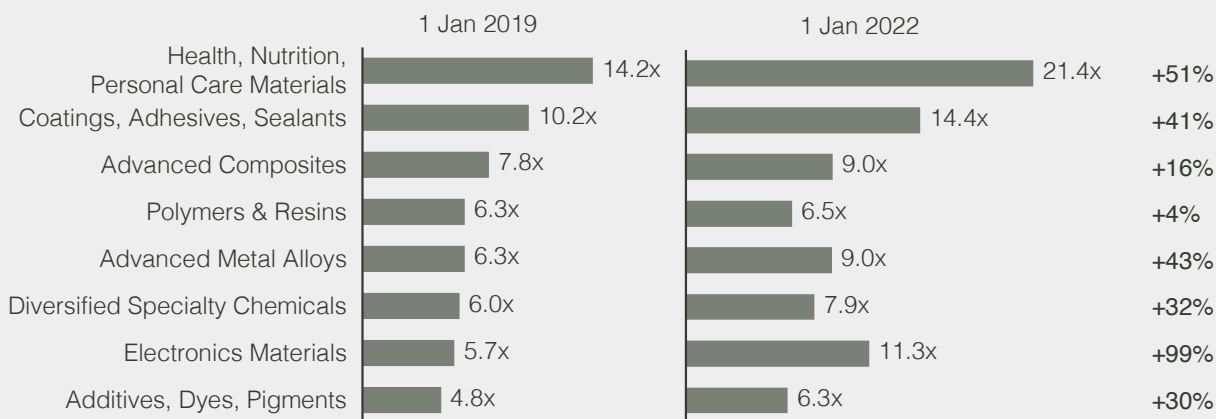
Changes in multiples were not uniform across advanced materials sub-sectors, as shown in the chart below. Companies in the electronics materials sector made considerable gains, particularly those serving semiconductor and electric vehicle battery markets. Increased demand and greater pricing power during the chip shortage drove some of these valuation gains.

Although multiples for polymers and resins companies appear relatively flat, the underlying data indicates a split in the market. Several companies have performed in line with other advanced materials sectors, with gains of the order of 30%, while others have remained almost static or dropped over this period. As a result, the median multiple showed little gain over the period.

Changes in the global economy look to continue to affect multiples going forward. As certain industries and end-markets are more affected than others, this snapshot may continue to evolve.

Valuations by material type

Median EV / EBITDA (NTM) multiples



Source: Koyfin, FMG Analysis

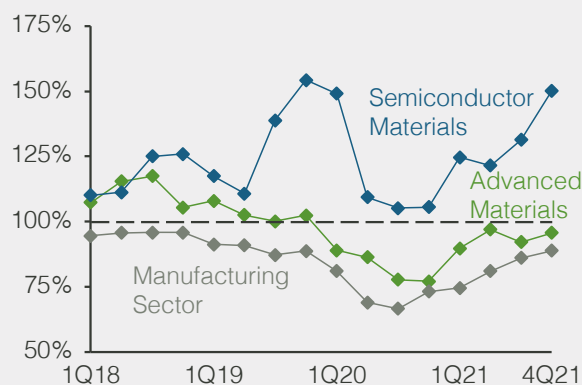
CAPEX levels increase but remain below replacement levels

Capital expenditures (CAPEX) by advanced materials firms increased throughout 2021 but remains lower than historic levels for the sector. Our first chart below shows the 'reinvestment ratio' or the ratio of CAPEX to Depreciation & Amortization. Generally, a number slightly above 100% shows a healthy level of investment. Sustained swings above this level can indicate sector growth. Falls below 100%, as seen in the chart, often reflect uncertainty about the market and a reluctance to invest in new assets.

Even before the pandemic, recession concerns in late 2019 caused many companies to slow investment levels. During the pandemic, the need to conserve cash and the inability of companies to progress on large investment projects caused a sharp drop in spending. S&P's Global Capex Survey reported a 6% decline in CAPEX globally that year across all sectors.

Reinvestment ratio

Ratio of CAPEX to D&A (seasonally adjusted)



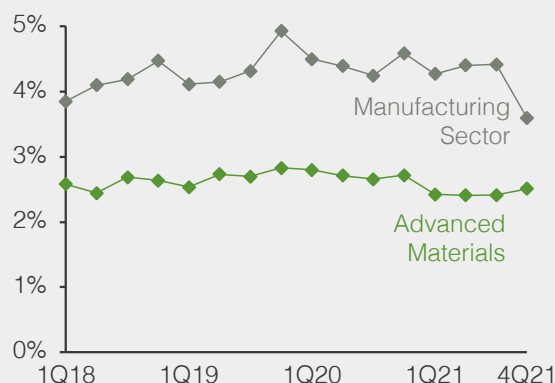
Source: Koyfin, Pitchbook, FMG Analysis

Yet despite the rebound in the global economy, CAPEX levels remain lower than pre-pandemic averages. Any investment in fixed assets must compete with other cash requirements, such as R&D spend (see chart), M &A, and share buy backs. Although R&D spend has remained largely flat, some companies may have offset lower CAPEX spending with increased acquisition activity.

However, the CAPEX downturn was not consistent across all sectors. As shown in the first chart, FMG's cohort of semiconductor material companies continued to show re-investment during the pandemic, at least partially driven by the global chip shortage.

R&D spend

Ratio of R&D to revenue



Source: Koyfin, Pitchbook, FMG Analysis

Historically, downturns in CAPEX have been followed by strong growth in CAPEX in subsequent years. Though current geopolitical uncertainty and concerns about rising interest rates may slow this growth, current data and market reports do point towards a recovery in CAPEX investments.

Private equity maintains a strong presence in advanced materials

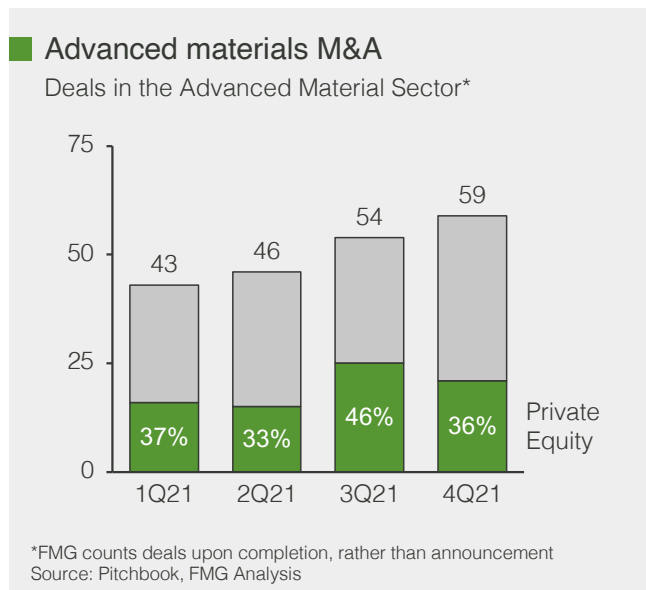
Global M&A activity across all sectors surged to record levels in 2021. Reuters reporting deal-making had exceeded USD 5 trillion for the first time by year-end.

Advanced materials saw healthy levels of M&A activity. FMG recorded over 200 transactions for the year in the sector (see 'How does FMG define the Advanced Materials Sector' on page 2 for more details on our criteria).

Of the deals in the sector, over a third are estimated to be led by private equity firms (see chart on next page). This would place private equity activity in advanced materials above the global, industry-wide average of about 30% for 2021 - a record level for private equity deal percentages since 2006.

One of the most active investors in the sector this year was Arsenal Capital Partners, with over a dozen acquisitions in materials and related applications. These investments largely built on the firm's existing portfolios in the adhesives and healthcare industries.

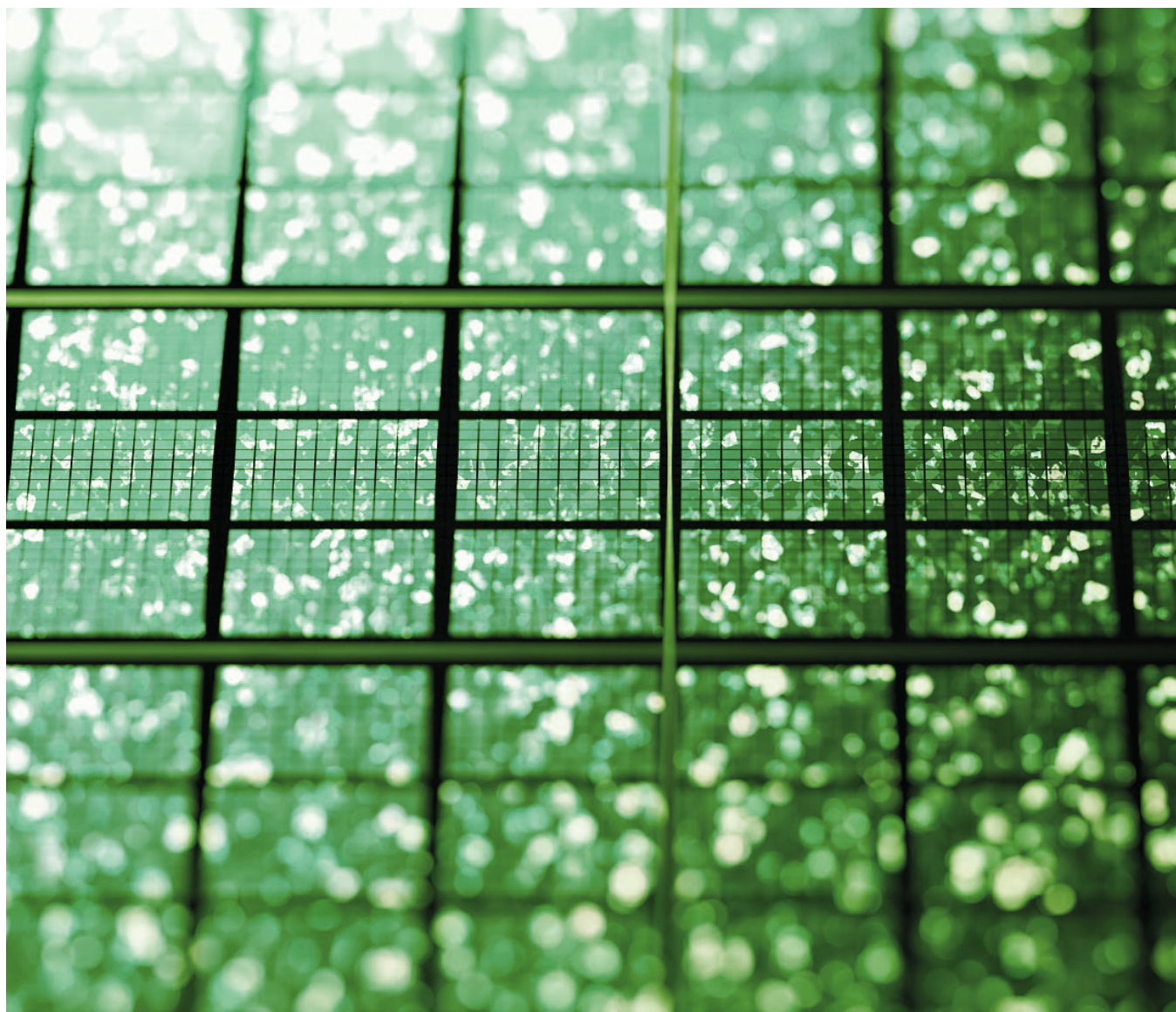
Private equity has steadily increased its presence in the



materials space over the last several years. Historically, the raw materials sector in general was viewed as

less attractive due to the level of cyclical and the amount of technical expertise required. However, this attitude appears to be changing as private equity firms demonstrate successful investments in the advanced materials market. For other firms, advanced materials offer an attractive alternative as they seek to realign their portfolios away from oil and gas due to ESG concerns.

When entering the materials sector, private equity has tended to focus on performance chemicals and materials rather than commodity or diversified chemicals. The relatively fragmented nature of the advanced materials industry allows them to build portfolios of companies with particular focus areas, while leveraging the experience of past acquisitions for future investments. Strategic investors will need to remain cognizant of high levels of private equity activity when developing and executing their own inorganic growth plans.



About FMG

Future Materials Group is an independent strategic growth advisory firm, specialising in the advanced materials and high value manufacturing sectors. Working globally, the company helps businesses at all stages of their development, from start-up to maturity, to create and increase value through rapid yet manageable growth.

Our advisory work is entrepreneurial, with unparalleled insight into markets, technologies, and trends that span our three practice areas: Strategic Growth, Mergers & Acquisitions, and Growth Finance. Trusted by business owners, boards of directors, and senior executives to define the right strategic priorities for growth, Future Materials Group delivers innovative strategies and solutions to make lasting and meaningful impact.

If you would like to learn more about our analysis or have any feedback on our market update, please contact us at info@futurematerialsgroup.com

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