

CASE Chemicals: Trends, Innovations, and Challenges



Introduction

The specialty chemical category referred to as CASE – coatings, adhesives, sealants, and elastomers – are essential materials throughout industrial and consumer product manufacturing. CASE provide advanced functional characteristics – e.g. performance, protection, operation, strength, and durability – that support a broad range of industries including medical, electronics, construction, automotive, aerospace, marine, packaging, renewable energies like solar and wind, and innumerable others.

The sheer size of CASE markets reflects their ubiquitous importance. Between 2019 and 2021, the annual combined CASE industries market was roughly \$267 billion USD. This astounding volume was led by coatings followed by elastomers, adhesives, and sealants.^{2,3,4}

- The global market volume of coatings was 10 billion gallons in 2019, and that's only the "C" in CASE materials.¹

CASE MARKET BREAKDOWN

- Coatings: \$137.1 billion USD (2021)
- Adhesives: \$43.75 billion USD (2020)
- Sealants: \$10 billion USD (2020)
- Elastomers: \$76 billion USD (2019)

COATINGS AND PAINTS

- Paints are a subset of coatings. As such, discussions of coatings in this white paper include paint unless noted otherwise.

The formulations and varieties of CASE chemicals are almost endless as manufacturers constantly evolve to innovate new products and processes to meet the changing needs of their customers. This white paper discusses each of the four CASE components, particularly their global market characteristics and industry trends. Recent innovative materials and applications are also considered along with key challenges facing the industry.

Coatings

Coatings are crucial to many industries where they provide protective, functional, elevated performance, or decorative properties to nearly everything we use. Some coatings even alter a product's surface properties to aid in the product's function. For instance, an important functional coating is used in the semiconductor and electronics industry, in which a light-sensitive polymer coating, called a photoresist, alters the semiconductor wafer surface, enabling control over doping and etching processes. Other functional coatings can change the substrate's properties, such as adhesion, heat-resistance, and corrosion-resistance.

ANALYSIS OF COATINGS AND PAINTS

- Learn more about analytical technologies for coatings at [Coatings and Paints](#).

Numerous industries rely on coatings for glass performance enhancements – architectural, automotive, solar panel and photovoltaic, and other industries that rely on glass with specific optical properties. Architectural glass manufacturers, for instance, use coatings that insulate, block UV rays, reduce glare, reduce breakage, provide privacy, and are decorative. Several window coatings are designed to optimize energy efficiency and play an important role in determining a window's energy efficiency rating or compliance, such as those associated with the Energy Star program in the U.S. and the Energy Performance of Buildings Directive in the E.U.

GLASS COATINGS

- Investigate the different uses and properties of glass coatings at [Glass & Glass Coatings](#).

Coatings also play a crucial role in the backend assembly process for semiconductors and integrated circuits (ICs) where they provide heat and protective resistance. Epoxy coatings are used for this manufacturing process to protect ICs from damaging particulates, moisture, and other environmental elements. The epoxies used must also resist final product stresses such as high temperatures and high impact, among others, to avoid delamination, voids, and other failure modes.

The coatings industry is very innovative and competitive. Manufacturers are continuously creating new and improved formulations to meet the needs of their innumerable end use industries. A few of the leading trends in coatings technology are antimicrobial coatings, nanocoatings, and sustainability advances.

Antimicrobial Coatings

The demand for antimicrobial coatings has rapidly increased since the COVID-19 pandemic. The global antimicrobial coatings market was \$9 billion USD in 2021 and is expected to grow at 13.8% CAGR from 2022 to 2030.⁵ The medical device and equipment segment led with 41% of the market, driven by the health care industry's demand for materials that help defend against pathogenic microorganisms. Other commercial and consumer applications for antimicrobial coatings include HVAC systems, sanitary and kitchen facilities, food processing and packaging operations, touchscreen electronic devices, building and construction materials, and numerous others.

Nanocoatings

The coatings industry is embracing advanced nanotechnologies in a wide range of industry segments – healthcare, automotive, electronics, building and construction, marine, and more. Nanocoatings are meeting the needs of these diverse end users thanks to their ability to work with both porous and impervious surfaces. Nanomaterials are truly multi-functional as evidenced by the many different properties they impart, such as:

- Prevent the growth of harmful microbes on medical equipment and devices
- Minimize fingerprint marks from forming on surfaces such as electronics screens
- Allow waterproofing of nearly any material
- Protect from scratches and corrosion
- Improve durability and lifespan

Nanocoatings also contain significantly lower levels of volatile organic compounds (VOCs) compared to most traditional polymer coatings, making them a sustainable alternative. These and many other characteristics make nanocoatings a truly innovative product.

Given the wide reach, versatility, and sustainability of nanocoatings, it is no surprise that the global nanocoatings market was valued at \$ 11.1 billion USD in 2021 and is projected to grow at 20.8% CAGR from 2022 to 2031.⁶

Sustainability

One commonly discussed topic in the coatings industry is the continued drive to improve the sustainability of products and processes. A review of industry events confirms the importance of sustainability. The agenda for the Coatings Trends and Technologies 2022 conference in the U.S. reveals that two sustainability topics – bio-based technologies and waterborne technologies – cover more than 50% of the conference presentations.⁷

Similarly, the European Coatings Show Conference 2021 devoted two sessions to waterborne coatings (seven presentations) and bio-based coatings (seven presentations). Other sessions that included presentations on these topics were Printing Inks, Adhesives and Sealants, Pigments and Fillers, Architectural Coatings, Polyurethanes, Wood Coatings, Protective Coatings, and Novel Materials.⁸

Numerous innovative bio-based coatings are being showcased at industry gatherings, such as:

- Alkyd emulsions based on tall oil fatty acid
- Polyols based on tall oil rosin
- Corrosion inhibitor based on sugar beet pulp
- Anti-UV coating using bio-carbon as UV-stabilizer
- Silicone additives made from sugar-derived ethanol and plant-based alpha olefins
- Resins based on corn and soybean byproducts from bio-diesel refinement

GREEN COATINGS

- The May/June 2022 issue of Coatings Tech is all about green coatings and sustainability. It is the 9th annual edition focusing on this important industry transformation.⁹

The continuing effort to develop coatings that have no or low VOCs is also part of the sustainability strategy. VOC emissions impact air quality and can negatively impact human health; thus, lowering VOC levels in CASE materials has been underway for a number of years.

Low-VOC coatings include those that are waterborne, powders, UV-cured, and high-solids. In addition to reduced environmental and human health impacts from VOCs, these materials have other advantages:

- Waterborne coatings are less toxic and less flammable.
- Powder coatings dry faster which saves energy; their production and use generate less waste; they provide superior corrosion resistance and high quality finishes.
- UV-cured coatings dry quickly which saves energy; the curing process requires less floor space which increases operational efficiency; they provide improved corrosion protection.
- High-solids coatings are very durable.

ADHESIVES PROCESSING

- Read more about adhesives processing methods at [Curing of an Optical Adhesive by UV Irradiation in the DSC 8000](#) and [Optimize Process Conditions of Resins and Composites](#).

Adhesives

Adhesives manufacturers continue to innovate new products to meet the needs of their diverse end users. The different physical forms of adhesives include pastes, liquids, films, and pellets. Additional variations include their chemical forms (epoxy, polyurethane, and polyimide) and classification as hot melt, thermosetting, pressure sensitive, or contact. This diversity of adhesive types requires different formulations and performance specifications.

ADHESIVES CHARACTERIZATION

- Investigate an improved method for characterizing adhesives at [Better Characterization of Hot Melt Adhesives Using the Double Furnace DSC](#).

Trends in the adhesives industry include:

- Steady growth in the building and construction segment
- Growth in the packaging segment to meet increasing e-commerce demand
- Emerging growth in adhesive tape demand in numerous segments
- Bio-based adhesives to meet sustainability goals and regulatory requirements

ADHESIVES MARKET

- The global adhesives market was valued at \$43.75 billion USD in 2020 with projected growth to \$65 billion USD by 2027. The end use segments with the greatest market shares are building/construction and paper/packaging.³

Sealants

Sealants are vital to many industries to prevent gas or liquid from passing into, out of, or through a material by creating “airtight” or “waterproof” seals. Physically reactive, non-reactive, and chemically reactive sealants can also provide thermal and acoustical insulation, possess electrical properties, and be used for simple smoothing or filling.

Trends in the sealants industry include:

- Steady growth in the building and construction segment
- Renewable energy growth, e.g., solar panel manufacturing
- Bio-based sealants to meet sustainability goals and regulatory requirements

SEALANTS MARKET

- The global sealants market was valued at \$10 billion USD in 2020 with projected growth to \$15 billion USD by 2027. The building and construction end use segment comprises the largest portion of the sealants market. The silicone product segment commands the largest market share at roughly 31% of product volume.³

Elastomers

Elastomers are a subset of polymers that possess incredibly versatile properties – high durability, strength, pliability, high thermal stability, great chemical resistance, high tensile strength, low shrinkage, high flexibility, low weight, good printability, and high surface quality. These properties enable elastomers to be used for an endless number of functions and industries.

Of the many trends in the elastomer industry, the following stand out:

- The automotive industry is increasing its demand for elastomers due to the need for high-performance, lightweight materials.
- The medical device industry is expected to be the fastest growing end use segment.
- The construction industry is increasing demand for elastomers because of their resilience, impact strength, high elongation, tear resistance, and abrasion resistance.
- Increasing availability of recycled elastomers is providing new opportunities for the industry and markets.
- Demand for bio-based elastomers is increasing to meet sustainability goals and regulatory requirements.

ELASTOMERS MARKET

- The global elastomers market was valued at \$75.56 billion USD in 2019 with projected growth of 4.8% CAGR from 2020 to 2025. The automotive segment held the largest market share.⁴

Innovative Materials and Applications

Changes in environmental regulations, increasing expectations for greater sustainability, and demand for higher performance – all at lower cost – continue to drive innovation in the CASE industry. The high functionality and versatile properties of CASE materials make them an R&D dream to meet each of those needs. The following examples of innovative CASE materials and applications demonstrate how this is becoming a reality.

Adhesives are Pushing Electric Vehicle Design Forward¹⁰

- Specialty adhesive formulations that are thermally conductive help maintain optimal battery temperatures during charging and operation, thus extending vehicle range and enhancing vehicle safety.
- Adhesive bonding provides crash durability and thermal conductivity while keeping the battery at a safe temperature.
- Structural adhesives help improve EV acoustics and driving performance.
- Multi-material bonding adhesives help bond dissimilar substrates, including the high-strength steel, aluminum, plastics, composites, magnesium, glass, and carbon fiber materials found in EV.
- Structural and thermally conductive adhesives for battery pack assembly reduce the number of components and the battery pack weight by up to 30 kg. Body bonding adhesives also help reduce vehicle weight.
- The same adhesive technologies that reduce weight also enhance battery pack assembly efficiency, reducing battery costs.

Ink Coating to Power Thermoelectric Devices¹¹

Researchers are closing in on a way to replace batteries for wearables and low-power applications on the internet of things (IoT). The answer lies in an ink coating that converts low-grade heat generated by devices into electrical power.

Marine Coating Saves Energy and Reduces Emissions¹²

Enterprises Shipping & Trading SA (EST) has selected a PPG biocide-free silicone fouling release coating for its ability to reduce the frictional resistance of the fleet's hull surfaces, thereby decreasing power demand and related emissions. EST vessels retrofitted with this energy efficient technology are demonstrating a power reduction of more than 20%.

Self-healing Coating with Weather-resistant Capabilities¹³

New polymeric material has been designed that can withstand extreme weather conditions and is capable of self-healing. It may be perfect for the aerospace and marine industries.

Graphite Coating to Overcome Equipment Failure¹⁴

Researchers are developing a new graphite coating that adheres tightly to a substrate material, significantly reducing energy consumption and equipment failure in conveyor systems.

Challenges and Needs

Amongst all of the functionality, versatility, trends, and innovations in the CASE industry, there are also challenges that must be addressed and needs that must be met. Some are situational, others are perennial, and still others are both perennial and unpredictable.

Supply Chain Disruption

One of the most frustrating current (2022) challenges is the disruption to global supply chains resulting from the pandemic. For CASE manufacturers, the first problem is the uncertainty about being able to obtain the raw materials upon which specific formulations are based.

Chris Fitzgerald, Global Vice President of CASE, Rubber, and Plastic Additives at Univar Solutions, describes his company's experience: "For much of 2021, almost 85% of all the specialty resins, rosins, monomers, silicones, surfactants, pigments, and additives we sell were on some sort of sales control or allocation at some point in the supply chain."¹⁵ Similar situations occurred throughout the CASE industry, and companies sought alternative sources for their raw materials and adapted their formulations.

When this occurs, it is imperative that each new material be thoroughly tested to ensure it meets the composition, purity, and chemical/physical properties required for the product formulation. If the material is deemed acceptable, a quality control (QC) run should be conducted and sample analyses completed on process intermediates and the final product.

Analytical Needs

During both routine and adjusted operations, CASE manufacturers need a robust and reliable analytical program that provides the information needed for evaluation of industry standards, regulatory requirements, and product specifications. Manufacturers need to ensure their testing program uses appropriate standard methods, such as those from ASTM, ISO, Federal and State regulatory agencies, and others.

The program should include standard procedures for:

- Qualifying raw materials and confirming formulations
- Monitoring process intermediates for workflow and regulatory compliance
- Confirming the final product meets regulatory, quality, and performance criteria

R&D teams also require robust and reliable analytical capabilities to evaluate raw materials and new formulations, test new products for adherence to end-use criteria, and reverse engineer a material for product improvement or competitive analysis.

Chemical testing requirements for all types of CASE chemicals include:

- Chemical fingerprinting
- Contaminant identification
- Residual solvents determination
- VOC content and off-gassing
- Metals content determination

The most commonly used chemical testing technologies and examples of their use for CASE materials include:

- Spectroscopic techniques such as Fourier transform infrared (FTIR) spectroscopy or Raman spectroscopy are used to determine the chemical fingerprint of a material.

FT-IR IN ENERGY CODE COMPLIANCE

- Learn how FT-IR is being used to check compliance with State energy codes at [Confirmation of the Presence of Styrene Butadiene Resin \(SBR\) Polymer in Drywall Primer Applications](#).

- Chromatography technologies such as gas chromatography (GC), ion chromatography (IC), liquid chromatography (LC), and gel permeation chromatography (GPC) are used in contaminant identification, residual solvents analysis, and VOC characterization.
- GC and LC are often hyphenated with mass spectrometry (GC-MS, LC-MS) to provide robust and highly sensitive detection, identification, and quantification of chemical components.
- Headspace analysis (HS) is used with GC-MS to quantify VOCs off-gassed from a material.

GC/MS IN QA TESTING

- Investigate a few ways in which GC/MS is used in both coating and adhesive QA testing at [Evaluation of Epoxy Quality by Determination of VOCs](#) and [Determination of VOCs in Wallpapers Using ATD-GCMS](#).

- Inductively coupled plasma optical emission spectroscopy (ICP-OES), ICP-MS, and X-ray fluorescence (XRF) are used to identify and quantify potentially harmful metals, especially in materials used in children's toys.

PROTECTION OF HUMAN HEALTH

- Learn about the importance of testing for toxic metals at [Speciation of Hexavalent Chromium in Children's Toys](#).

The battery of physical properties analyses required is specific to each product. The most widely used and versatile technologies for physical property testing and examples of their use include:

- Thermo-gravimetric Analysis (TGA) and Differential Scanning Calorimetry (DSC) are used to determine melting point, transition temperature, and liquid/solid content.
- Dynamic Mechanical Analysis (DMA) is used to investigate the stiffness of a material as a function of temperature, humidity, dissolution media, or frequency.

DMA VERSATILITY

- Read about the use of DMA for physical properties evaluation at [Mechanical Properties of Films and Coatings and Effect of Saline on Epoxy Resin Paint Run in Tension Geometry](#).

- Optical and electron microscopy are used to identify solid components, measure particle size and distribution, and measure layer thickness.
- Scanning electron microscopy (SEM), optical digital microscopy, and confocal laser scanning microscopy are used to evaluate coating surface features such as thickness, density, hardness, and scratch resistance.
- Ultraviolet-visible-near infrared (UV/Vis/NIR) Spectrometry is used to measure the amount of light transmitted through, or reflected by, glass windows.

End product performance testing is conducted using a variety of methods for characteristics such as durability, weathering, strength, flexibility, chemical resistance, corrosion resistance, barrier effectiveness, and other product-specific end use parameters.

BUILDING GLASS

- Learn about building glass testing at [Material Characterization Analyzers for Building Glass Measurements](#).

The Challenging Regulatory Landscape

Environmental regulations continue to change in countries and regions across the globe. For CASE materials, one primary environmental compliance point is the VOC content of materials. The industry has made great advancements toward low- or no-VOC formulations, which helps meet air emission standards as well as reducing VOC waste streams. Even so, manufacturers would be wise to continue looking for ways to further reduce emissions and wastes from their operations in anticipation of further tightening of regulations.

Sustainability programs continue to grow as well. Net-zero carbon emissions is a significant component of such programs, along with transitioning to bio-based materials and creating a circular “no waste” economy. Again, companies would be well advised to find ways to make progress in this arena in anticipation of increased requirements in the not-so-distant future.

SUSTAINABLE BUILDINGS

- Learn about testing methods for sustainable building materials at [Green Building Materials Analysis with UV/Vis-NIR and Infrared Analytical Solution](#).

Conclusion

The CASE industry is full of possibilities and is pushing ahead with innovative materials and processes. The analytical technologies industry is working in parallel to provide them with the advanced testing capabilities they need to thrive.

References

1. [Statista. 2021. Paint and coatings industry worldwide- statistics & facts.](#)
2. [Mordor Intelligence. 2022. Paints and Coatings Market - Growth, Trends, COVID-19 Impact, and Forecasts \(2022 - 2027\).](#)
3. [Statista. 2022. Global market value of adhesives and sealants, 2019 and 2026.](#)
4. [Grand View Research. 2020. Elastomers Market Size, Share, and Trends Analysis Report.](#)
5. [Grand View Research. 2022. Antimicrobial Coatings Market Size, Share, and Trends Analysis Report.](#)
6. [Transparency Market Research. 2022. Nanocoatings Market.](#)
7. [Coatings Trends and Technologies 2022.](#)
8. [European Coatings Show Conference 2021.](#)
9. [Coatings Tech. 2022.](#)
10. [ASI. 2021. Seven Ways Adhesives Push Electric Vehicle Design Forward.](#)
11. [SpecialChem. 2022a. KTH to develop Ink Coating Enabling Thermoelectric Devices.](#)
12. [SpecialChem. 2022b. PPG's Fouling Release Coating to Turn EST's Fleet Energy Efficient.](#)
13. [SpecialChem. 2022c. New Self-healing Coating with Weather-resistant Capabilities.](#)
14. [SpecialChem. 2022d. New Project to Develop Lubricant Coatings for Energy-efficient Conveyor Systems.](#)
15. [PCI. 2022. Five Key Insights to Help the Coatings Industry Plan for the Future.](#)