Manufacturers constantly strive to make coatings and adhesives more durable and functional. Recently, some have discovered that a time-tested, versatile technology provides opportunities to include high-performance additives that help those products more effectively beautify, protect and seal.

Microencapsulation technology makes it possible to add materials that would have shorter useful lives or be outright incompatible with the base product if mixed conventionally. Microencapsulation already enables coatings to be infused with longer-lasting biocides for protection against mold and mildew, and also creates potential for extraordinary new applications — like a wall coating that helps moderate the temperature of a room, or a finish that can self-heal if scratched.

Microencapsulation effectively seals an additive within a microscopic wall so that it remains isolated from the base product until it is released in response to some stimulus. While proven for decades in other industries, microencapsulation is just now gaining consideration for coatings and adhesives. Its potential appears limited only by the collective ingenuity of product manufacturers and microencapsulation experts.

New Uses for Microencapsulation
Microencapsulation is the process of putting a microscopic wall around a core substance. To envision this technology more easily, think of a candy-coated chocolate as a microcapsule. In this case, chocolate (the core payload) is held inside the candy shell. To prevent melting chocolate from making a mess all over your hands while eating the candy, the payload is not released until you break the capsule with your teeth, or let the moisture in your mouth slowly dissolve it. This provides the best of both worlds: the taste of chocolate without the mess. Now think of all of that happening at a microscopic level.

Microencapsulation was invented for one specific purpose: to find an alternative to ink ribbons used inside cash registers. NCR Corporation scientists invented and patented the process known as chemical microencapsulation. They turned to Appleton Papers to develop a workable microcapsular coating that led to the introduction of carbonless paper in 1954.

The Appleton scientists who continued to work with microencapsulation technology recognized the potential for microencapsulation to extend to other applications beyond carbonless paper. However, the ongoing growth and development of the carbonless paper industry kept those scientists focused on supporting Appleton’s primary product for decades.

More recently the scientists with expertise in chemical microencapsulation have begun to use their unique and extensive expertise in microencapsulation to develop specific and often proprietary product solutions in the consumer products industry. At Appleton, these efforts gave birth to Encapsys®, a division within the company that uses a collaborative approach between our own scientists and partner companies to develop smart chemistry solutions.

Procter & Gamble was one of the first companies to consider using the potential of microencapsulation to manufacture a better product, and they turned to Encapsys for help. Working closely with P&G, the Encapsys team created microparticles that are capable of performing as needed in P&G’s products, helping to deliver a heightened consumer experience while also meeting their business needs. P&G provides the need for microencapsulation technology, and Encapsys delivers the solutions. Encapsys recently used the same approach with a noted performance materials manufacturer and entered into a supply agreement to develop and supply a microencapsulated biocide to select marketplaces worldwide.

Open innovation and collaboration between microencapsulation companies and producers of coatings and adhesives could lead to new solutions for old problems or to product opportunities that were believed to be impossible. The only way to find and recognize these solutions and opportunities is through an open dialogue between collaborative partners.

Potential Opportunities to Expand the Capabilities of Coatings
When mixed conventionally, additives like antimicrobial agents, fungicides or mildewcides in architectural coatings are typically short-lived. Encapsulation has demonstrated the potential to extend the release profile and allow the coatings to protect the surface for years instead of only weeks or months.

Similarly, corrosion inhibitors in paint could be encapsulated to release only under specific conditions, such as a certain pH level or cumulative exposure to ultraviolet light. Released only as needed, the inhibitor could protect significantly longer than a traditional finish.

Chemical microencapsulation could, potentially, benefit the coatings industry in a variety of other ways that enhance products more subtly. These could save many

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manufacturing companies a great deal of money and also create better products for consumers.

**Keeping Ingredients Separated**
Microencapsulation can also enable mixing of substances that would separate, clump together, or react chemically if mixed in conventional ways. An obvious example would be mixing an additive with paint. Encapsulation could allow the substance to reside in the paint until the time of application, when capsule breakage or some other trigger would release it.

**Protecting Product Utility**
Microencapsulation could also protect additives that would otherwise slowly deteriorate in solution over time. No longer needing to allow for losses during shipment and storage, the manufacturer could add the optimum amount, which could reduce costs and extend the product’s shelf life.

**Enhancing Consumer Safety**
Another potential benefit of microencapsulation is enhanced safety in product handling. Additives that in raw form might pose safety concerns could be isolated in capsules engineered for release only after the product was applied and exposed to an appropriate trigger. Human exposure would be reduced at both the production and end-use levels.

**Self-Healing Coatings**
Microencapsulation might provide self-healing for scratches to flooring, car or boat finishes, furniture and appliances, which can be difficult to detect and costly to repair. Here, a scratch would release microencapsulated material that would re-seal the break in the coating and protect the substrate. The encapsulated material could be more of the same paint or varnish used in the finish, or a protective substance that would simply exclude moisture to prevent rust or other deterioration. The infused coatings could be designed to last the life of the substrate. Similarly, plastic or fiberglass could be impregnated so that in case of a minor break, the material would fuse back together, providing enough strength to prevent outright failure until the time of repair.

**Protecting Brand Owners and Consumers**
Beyond providing physical protection, microencapsulated ingredients in inks or coatings could fulfill various marking and indicating functions, showing when an object has been damaged or has taken an impact, even when evidence of the event might not otherwise show.

For example, a shipping container that has been dropped or struck might bear no obvious signs of damage although something inside is broken – but an encapsulated pigment released on impact with the surface would leave an obvious mark, alerting the recipient to inspect the container before accepting it.

In similar fashion, an encapsulated pigment with a temperature trigger could indicate that a container of medicine or other perishable good had encountered excessive heat during storage or shipment.

The same basic concept also could apply to indicating impacts to cars and boat hulls, or to lift trucks and other industrial vehicles in factories and warehouses. Closer to the consumer level, a motorcycle or bicycle helmet could show a mark and/or emit a scent if an impact caused a crack that would compromise its integrity.

Microencapsulation also has potential to support brand protection and product authentication. Possible applications include:

- Validating the brand identity or age of a coating in assessing warranty claims.
- Tracing a coating back to a specific production lot.
- Using a specially formulated coating or ink as a signature to distinguish genuine products from counterfeits.
- Making packaging adhesives tamper-evident, so that they release a color or aroma if a seal is broken.

For Coatings Through Microencapsulation
Expanding the Functionality of Coatings Through Chemical Microencapsulation

Helping to Regulate Temperatures

Looking to even more advanced applications, microencapsulation could make a paint or plaster that works in concert with building heating and cooling systems possible. Here, coatings would be infused with capsules containing a phase-change material – a substance that changes between solid and liquid phases at temperatures commonly encountered in indoor spaces.

Changes in phase absorb or release heat energy while the temperature stays constant – for example, a glass of water containing ice cubes remains at 32 °F until the ice is melted.

In the same way, microencapsulated phase-change material added to plaster and applied to a wall would absorb the energy of sunlight through the windows, moderating the sun’s effect on the room’s temperature. Then, at night, the phase change would release the energy, slowing the room’s cooling. The net effect would be to keep the room temperature more consistent and comfortable, save energy, and conceivably reduce the size of the furnace or air conditioner needed for the space.

Because the microcapsules would not break, the phase-change material in the plaster stays contained and could conceivably function for decades. In a similar way, phase-change coatings could be applied to upholstery to make furniture more comfortable, to the fabric of high-performance athletic clothing to help keep wearers warm or cool, or to computer batteries or electronic components to moderate temperature variations.

Collaborate to Innovate

These current and potential applications most likely mark just the beginning of possibilities for chemical microencapsulation in the coatings industry. Success in generating ideas and bringing them to market depends on collaboration between brand owners/product manufacturers and microencapsulation innovators. The microencapsulation innovator relies on the customer’s product knowledge and market insight, while the customer takes advantage of the depth and breadth of the encapsulation company’s technical expertise and manufacturing capability. The two working together can produce innovations faster and more effectively than either party could alone.

Coatings and adhesives suppliers seeking to create new markets or gain competitive advantage can benefit from considering microencapsulation and the potential it can provide. When the right partners combine the necessary market insight and technical savvy, the possibilities are almost limitless.

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