Radiation-Cured Coatings Take Center Stage

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Increased productivity, enhanced product performance, greater cost efficiencies, and environmental compliance: these benefits of radiation-cured coating processes continue to drive the growth of this sector of the paint and coatings industry.

Radiation-curable (radcure) coatings consist of coatings that can be cured by either ultraviolet (UV), visible, or electron beam (EB) radiation. Formulations generally consist of oligomers, monomers, a photoinitiator, and additives.

According to The Chemark Consulting Group, the global radcure coatings market in 2006 totaled 1.8% of the entire coatings market. The consulting firm estimated that this share would increase to 2.2% by 2012.

North America accounts for the largest portion of radcure sales by region. Emerging markets, however, are experiencing the fastest growth rates.

In 2007, the value of the North American formulated UV/EB market was $2.4 billion, according to Dan Murad, president and CEO of The ChemQuest Group, Inc. A strong annual growth rate of 8% reflects the growing interest in this sector of the coatings industry.

Within North America, the U.S. dominates with 88% of all UV/EB installations. UV curing is predominant and accounts for 90% of the radcure processes, but some believe that EB is growing faster than UV.

The greatest growth for radiation-cured coatings, however, is in emerging regions of the world. In places like China and Eastern Europe, where many new coating operations are being established, there are no concerns about making additional capital investment costs to replace existing equipment. In many cases, new facilities are installing UV/EB processes initially because of the benefits the technology provides.

"The industry value proposition for radiation-cured coatings is multi-layered," Murad notes. Key advantages include increased speed and cycle time, improved coating properties, environmental compliance, and the fact that radcure is an enabling technology.

Michael Kelly, president and CEO of Allied PhotoChemical, equates UV curing to an improved return on investment plus environmental benefits. "Coating optimization, reduced Work in Process (WIP) and energy costs, lower maintenance costs, and decreased overall quality costs are combined with a cleaner process that involves zero VOCs and no HAPs, and as a result has reduced environmental reporting requirements and lower emissions handling costs."

Improved productivity can be linked to increased line speeds, reducing curing temperatures and smaller footprints. Exposure times can be as short as one second or less, and common web line speeds reach 1,000 ft/min. UV/EB systems are generally compatible with most all application techniques and can usually be installed on existing production lines.

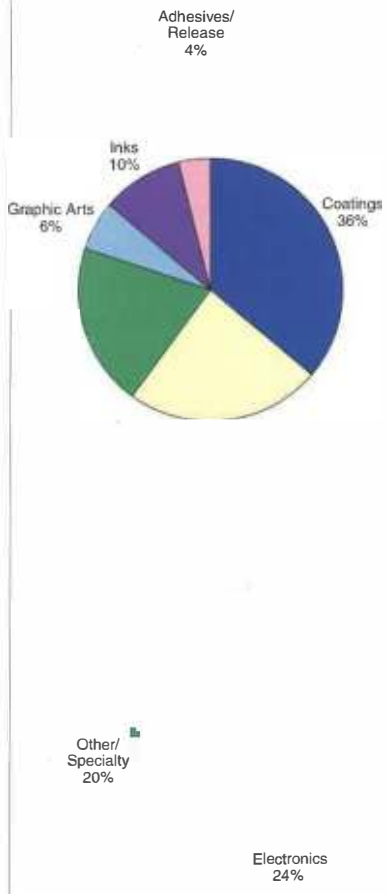
For example, notes Petra L'Abbe, global market manager, Consumer Products, PPG Industrial Coatings, as the military and aerospace companies look to reduce their trim painting operations from days to hours, UV is becoming a formidable prospect. "In industries such as electronics, wood, and graphics, speed means rapid throughput with immediate packaging and shipping capability," she adds. "In this sense, UV and EB are truly just-in-time technologies."

Enhanced coating performance is also a very important factor for many who have elected to adopt radcure processes. "Improved physical properties include better durability, scratch and corrosion resistance, and clarity," Murad explains.

Even though being "green" is a growing factor in the coatings industry, and radiation-cured coatings offer many benefits in this regard, environmental issues often fall third or lower on the list of reasons why many switch to radiation-cured coating formulations. Michael Kelly agrees that, while no one will pay more for the environmental benefits, they do get people's attention. The many advantages include no solvent or VOC problems, high transfer efficiency, and low energy consumption—and these pluses will help drive growth as sustainability and green chemistry become increasingly important.

Radiation curing is also an enabling technology, giving manufacturers an opportunity to make products not previously possible. Because they are low temperature processes, radiation-curing technologies make it possible to coat heat-sensitive substrates such as plastics, which cannot be practically achieved with thermal curing processes.

Coatings, electronics, inks, and graphic arts are major segments where radcure is used and account for 76% of all radcure sales, according to Murad (see *Figure* 1, below).



Within the coatings segment, wood, plastic, and electronic applications are the major end use categories.

Wood applications include flooring (parquet and hardwood planks), cabinetry, and post-assembled furniture and cabinetry. Digital inkjet printing to create the look and feel of a specific wood grain on solid pieces of wood that have no discernible grain of their own is a potentially big opportunity, according to Murad. UV-cured coatings are used in this application to provide a clear topcoat.

One of the greatest opportunities for the radcure sector lies in the possibility of using radiation-cured coatings in flexible packaging for foods. The RadTech Food Packagers Alliance is working to get Food and Drug Administration (FDA) approval for direct contact with food for UV/EB curable packaging resins. If they are successful, food packagers will be able to switch from a horizontal filling process to a vertical, rotary filling process that is up to 10 times faster. The use of radiation-cured monolayer films with short sealing times instead of the currently employed multilayer laminants that require longer sealing times is the key to making the switch possible.

Electronics applications include touch screen control devices where a clearcoat provides a protective barrier. In many cases, these new applications involve a combination of radcure technology and nanotechnology. "We are also seeing a significant movement for using radcure technology for clearcoating plastic surfaces like keyboards that have digital printing on them that must be protected," Murad notes.

Interior aerospace and defense applications are another growth area. ChemQuest also believes that with advancements in adhesion properties for metal substrates, radcure coatings will experience increased demand for coil coatings and other applications.

"There is considerable investment in R&D on UV and EB technology that continues to make this

technology even better," asserts L'Abbe. "Significant work on metal and plastics applications has opened up new applications using both of these substrates. Lower costs from UV/EB suppliers and a wider selection of materials and equipment will also continue to expand the use of the technology."

Radcure coatings are also very adaptable and the technology is being used in novel ways, not just in a production line manufacturing setting. "We are seeing UV-cured coatings used at the end of production lines and in off-line or repair applications," L'Abbe notes. Examples include new products developed for automotive repair and refinish and rapid field repair for the military. These developments are made possible as new materials and portable equipment become available.

The introduction of portable curing equipment has also led to potential growth areas for radcure coatings in the contractor segment. One particular area is the coating of commercial concrete floors. "In commercial spaces," notes Murad, "there is a huge incentive to minimize down time and get the floor coated and cured as fast as possible." This new walk-behind, portable technology allows a contractor to apply and cure the coating very quickly.

Even with these numerous potential growth opportunities, the radcure industry still faces several challenges. "The necessary capital equipment outlay continues to be a hurdle for many considering a switch to radiation-cured coating technology," Murad asserts. "People often would rather not have to spend money to replace existing equipment that uses familiar conventional technology."

L'Abbe adds that, "Even when compelling issues arise, such as compliance with VOC regulations, some may opt for an 'easier' path and simply add pollution control devices to existing equipment rather than move to a more environmentally responsible process like UV/EB."

Potential users must also be educated about the higher cost of UV/EB formulations compared with formulations designed for thermal cure. "While the formulation cost in dollars per gallon is higher than that for conventional coatings, the actual applied cost is very similar, and in some cases can be lower, due to the cost efficiencies and productivity increases gained with radcure processes," says Murad.

The cost of curing three-dimensional pieces is often even higher than the radcure coating process for flat parts. Newer, specialized acrylate resins and the automated equipment necessary for achieving systemic curing of the entire area on 3-D parts add to the cost, according to Murad.

Beyond improving the understanding of the technology, there is also a need to improve some aspects of the radcure process, including the equipment. Apparently the lamps used to cure UV/EB can produce variable energy levels when they approach the end of their life time. Variable energy levels translate to variation in curing, which in turn means inconsistent quality of the final coating.

This issue becomes more of a concern when multiple lamps are used in a web curing process for larger pieces. "As the output of the different lamps varies, variations in curing occur within the coating of the part, and that becomes a real quality issue," Murad states.

He suggests that one way to overcome such problems is to increase cooperation between the different suppliers to the sector. "The way the market is set up today, suppliers of lamps, resins, and photoinitiators all work independently. There needs to be a more comprehensive approach so that effective solutions can be developed."

Working closely with the various players in the sector and developing strong customer relationships is critical, agrees Kelly. "At Allied PhotoChemical, we focus on innovation and providing a rapid response to customer inquiries. Because we specialize only in UV-cured coatings, we have developed extensive expertise in this technology and are able to convert that experience into measurable benefits for our customers."

Allied PhotoChemical's product portfolio is fairly diverse and includes UV conductive inks, UV dielectrics, stereolithographic resins, clear and colored UV products, and specialty UV formulations.

PPG's latest UV-cure product is marketed under the name CeranoShield® and forms a hard, transparent, glass-like surface onto a wide range of plastics. The product resists scratching and hazing better than current industry available coatings and can be used for touch screens, optical displays, and many other plastic applications, according to L'Abbe.

The company has also recently introduced a new nano-based flooring topcoat with excellent scratch resistance, and has other UV-cured coatings for wood products including a spray-applied formulation for kitchen cabinet doors that comes in multiple colors and styles and vacuum coat products for moldings, stair noses, and flooring transition parts.

Allied PhotoChemical and PPG will be two of over 100 companies highlighting new technology developments at the upcoming Radtech UV/EB conference and exhibition in Chicago, IL, May 4–7, 2008. Presentations will cover green chemistry, renewable resources, sustainable packaging, regulatory issues, nanomaterials, technical developments in China and Japan, and will also address issues relating to many different UV/EB application sectors.