Commercial Applications of UV/EB in Graphic Arts

By Anthony Bean, Sun Chemical. Updated by Howard Ragin, UV Specialties, LLC.

Ultraviolet (UV) and electron beam (EB) technologies are used in a wide range of industrial applications. UV/EB technology is used to cure dental fillings; form 3D images and castings for stereolithography; manufacture contact lenses; sterilize water, food and mail; etch various metals; and cure inks, coatings and adhesives. End uses range from construction to consumer materials.

UV/EB applications have become so prolific that it is impossible for a person to venture out without running into at least one application of the technology, whether it is recognized or not. The application of these products covers the gamut of methods from simple dipping to sophisticated powder and sprayer techniques.

Quick summary

UV/EB inks and coatings have been used in graphic arts since the early 1960s. Their use continues to grow as UV/EB curing becomes the technology of choice for many printers and converters.

Some uses for UV/EB technology include:

- Printing plates – both flexographic and lithographic
- All types of printing processes (flexographic, lithographic, screen, digital and letterpress)
- Coatings with a full range of gloss and feel, chemical and abrasion resistance
- Adhesives

In flexible packaging, UV/EB coatings are used to replace one of the film layers in a multi-film laminate.

Overview

Use of UV/EB technology within the graphic arts industries has continued to grow in many areas. Beginning with UV-cured printing plates for lithographic, letterpress, screen and flexographic application of inks and coatings, it has been a fundamental part of the industry for many years. Although it never became a commercial reality, the use of EB to engrave gravure cylinders was experimented with in the late 1970s.

UV/EB inks and coatings were developed in the late 1960s. Adhesives took a little longer to develop, but today they have become common in a wide variety of applications. The original driving forces behind the commercialization of the technology were energy savings and freedom from solvents. These benefits have been supplemented by the high productivity, unique structures and subsequently higher profits that can be obtained with the industry's ever-increasing line speeds and the needs for "instant" products. Competition has provided the spark that has allowed the industry to overcome one technological hurdle after another. For example, food packaging applications were challenged by material migration. Now, this is achieved simply by proper formulation and processing. Material advances have enabled the formulators to expand the capabilities of the finished products.

Printing plates

Research on photopolymers in the 1950s led to the introduction of photopolymer printing plates in the 1960s. The faster and easier processing of the printing plates and the improved printing quality of the plates resulted in a rapid acceptance by the printing industry. In the 1970s, new instant printing shops, based upon this technology, began to appear in the marketplace. Production of photopolymer plates has been combined with computer technology to create desktop publishing. Photopolymer plates have led to improved quality in production of color separation and color reproduction.

Design of photopolymer plates is specific to both the type of press and type of ink being used. Photopolymer plates are available for use with UV- and EB-curable inks and coatings, as well as conventional water-based and solvent systems. Photopolymer plates are used in letterpress, flexographic and lithographic printing applications.

State-of-the-art lithographic photopolymer plates are generated directly by using a computer controlled laser beam to expose the plate. Thus, no negative or paste-up is required to provide the final press-ready plate. This also allows printing to occur simultaneously at any number of sites, as well as being imaged on the press.

Printing inks

The first commercial use of UV-curing inks took place in fall 1969 on a large-format lithographic sheetfed press to print folding cartons. Despite the fact that many experts stated that highly pigmented inks could not be cured with UV light due to the absorption of the UV light by the pigment, chemists found a way to make it work. The advantages of instant drying, the lack

of solvents and improved physical properties were the initial drivers.

At about that time, a natural gas shortage forced many printers to adopt the technology since the fuel needed to run the large ovens was too expensive or just not available. This moved the technology into web printing and metal decorating which used enormous amounts of natural gas to dry their inks and coatings. The Coors Brewing Company elected to convert all of its conventional presses used for printing and coating two-piece cans to UV drying.

The cost of the new chemistry prevented the inks, coatings and adhesives from being widely accepted. More research was needed to overcome technical issues related to the UV chemistry. EB also found a niche, but the high costs of the equipment slowed the growth in this arena until newer technology brought the costs down considerably.

Other hurdles for UV/EB technology have been and continue to be surmounted. Naysayers doubted the ability of UV/EB technology to satisfy the needs of flexographic printing, which requires low application viscosities and low solvent formulations. Today, however, this is a thriving commercial area. Odor and off-taste were a concern in food packaging, but now even direct food contact is possible for some systems. Progress has been made with all of the issues, and the acceptance, as well as the expectation, of UV/EB technology continues to grow.

Screen printing uses UV inks for just about every application. Decals, posters, vehicle signage, electronics, bottle decoration, textiles, labels, automotive and many other applications rely on UV curing to provide reduced solvents, instant drying, improved print properties and ease of application.

Lithographic printing uses UV/EB curing for a wide range of products from cereal boxes to glossy magazine covers. The high gloss of the UV/EB coatings has become the standard in the industry. Applications requiring low odor and low off-taste are moving to UV/EB technologies due to the cure consistency that they provide. Such items as pet food, tobacco and chocolate use the technology to enhance the packaging and to boost sales. Many sheetfed metal packaging products also are decorated with UV-cured inks. UV inks are being used on coldset newspaper presses printing on coated papers, which is the paper commonly used for advertising and coupon inserts.

Letterpress printing of plastic containers using UV products has all but eliminated the use of solvent inks and coatings due to higher productivity, improved finished product performance properties and environmental benefits. The use of UV curing allows letterpress to be easily combined with screen and flexographic printing on combination presses to print labels

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because of its quick cure. In this manner, the UV process has enabled the best of each printing process to be utilized.

Flexographic printing of narrow web applications reached commercialization quicker than wide web. The smaller presses allowed the use of higher viscosity materials. Although wide web applications started around 1990, they still haven't found much acceptance. The slow adoption of the technology in wide web applications that are non-food packaging is mostly due to the overall cost increases. Some specialty areas like outdoor bags are able to pass on the increased ink costs due to the higher performance of the UV or EB inks.

In the larger food packaging application, concerns about migration of ink materials through the films or from set-off have hindered acceptance. Newer chemical technologies have allowed some EB coatings to achieve Food and Drug Administration (FDA) compliance. Compliant EB inks now can be formulated, but presses with EB units are not commonplace, and some practical application issues need to be resolved.

Since normal flexographic printing requires the inks to be dried between each color, the use of EB technology was prohibitive for both cost and space on the press, as multiple EB curing units would need to be installed. The recent commercialization of systems that allow wet trapping of inks now allows both EB curing to be used and eliminates most of the issues holding back UV technology from penetrating wide web flexographic printing.

Gravure printing with UV- or EB-cured ink is being developed but has not received much attention at this time. Until the market forces are in place to encourage the use of the technology, chemists will not expend the effort to develop UV/EB gravure inks. This is not to say that this is impossible, but the return on the investment does not appear to be sufficient at this time.

Inkjet printing or digital printing is not only the fastest growing opportunity for UV technology but also has become the

norm for inkjet inks. Products ranging from simple coding of boxes with date stamping to large format signage are rapidly being introduced. Various print engines (ink print heads) are being adapted for more applications daily. Print quality rivals other, more traditional forms of printing, and costs continue to decrease. This in turn continues to accelerate the adoption of the technology in broader applications. The shorter-run conventional printing processes already are feeling the pressure from this newer technology.

Coatings

The applications for coatings (clearcoats) in graphic arts have penetrated almost all of the possible end uses from cans to labels to folding cartons to magazines. The high gloss that both UV and EB products are noted for producing has become the standard to which other technologies strive. Combinations of the typical glossy products with dull or matte coatings produce a unique effect often used to highlight images. As mentioned before, some EB coatings have achieved FDA compliance. UV chemistry is expected to eventually achieve compliance with newer technology both in formulation and processing equipment.

Besides the high luster that the coatings provide, UV/EB coatings afford improved resistance properties for chemical and physical protection. Both coatings have expanded characteristics in the area of tactility. They are able to provide a soft touch through sandpaper roughness. With screen application methods, raised images of near 3D look are available. Typical solvent- and water-based products cannot duplicate these enhancements easily.

In flexible packaging, UV/EB coatings are being used to replace laminations in areas where one of the laminated films is used only to provide aesthetics or resistance – not barrier properties. At this time, UV/EB coatings are not capable of providing high barrier properties for moisture or oxygen, but that may change as continued research makes strides in this area.

Due to the promising properties that UV/EB coatings offer, most presses are sold with coating units, even if the printer is not using a coating currently. This is particularly true in the sheetfed lithographic market, where water-based products have been used for a long time. UV coatings are replacing water-based coatings due to improved performance properties, gloss options from extremely high to matte, elimination of drying problems and the overall economics of higher productivity.

UV/EB coatings applied by lithographic press (litho varnishes) are only a small part of the overall coatings business. Because of the mechanics of the litho process, they do not offer the very high gloss of a typical UV/EB coating. Litho varnishes are used in some cases just to apply a sheen and give some resistance properties to the printed product.

Applications for release coatings are expanding in the graphic arts market. The use of various siliconized products has been commercial for many years in a variety of uses. UV/EB technology has grown in the flexible packaging market, and testing of an application called "cold seal release coatings" has started. Currently, it would appear EB has a lead in this area due to the more consistent cure and the lack of photoinitiators that cause migration concerns.

Adhesives

UV- and EB-curable adhesives continue to be a growing segment of the overall radiation curing market. They represent an increasingly attractive alternative to solvent-based, water-based and hot melt technologies. Structural, pressure sensitive, laminating and transfer metallization adhesives are all seeing increased use. Many of the applications are quite sophisticated, such as EB-cured transfer metallization adhesives for gift wrap. This process can be adjusted either for full sheet metallization or selective pattern graphic effects that cannot be duplicated by the more conventional processes, such as metallic inks.

UV laminating adhesives have been slow to be commercialized in the United States as compared to Europe, but this continues to change. Their ease of use, rapid cure, lack of solvents and low energy requirements are beginning to interest US laminators. The development of technology using cationic chemistry and visible light initiated systems is helping to overcome hurdles, such as laminating polyester film (absorbs UV but not visible light). With the development of lower cost EB units, EB adhesives are enjoying significant interest, as mentioned above, in food packaging applications. Again, the use of EB eliminates one of the major concerns with UV adhesives – photoinitiator migration.

Commercial adhesive products are produced on UV/EB equipment. They include pressure sensitive tapes and labels, laminated foils and films, flocked materials for automotive and shoe applications, structural adhesives and abrasive bonding systems. The advantages of these adhesives are single-component materials that can be dispensed with automatic equipment, long "open time," fast cures, lower energy requirements, ability to precision bond and low heat input to temperature-sensitive substrates. ■