

# The Inks Market: *Shades of Gray*



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**T**he printing ink industry, including ink manufacturers and their suppliers of key ingredients such as solvents, resins, waxes, oils, and other additives, has faced challenging market conditions in recent years, with little change expected in the months to come. Higher raw material and energy costs, increasing globalization, competition from China and India, offshore production of key substrates, and growing interest in electronic media all threaten the profitability of the printing ink market.

Annual sales for the U.S. printing ink industry are estimated by the National Association of Printing Ink Manufacturers (NAPIM) to be \$4.2 billion. Industry sources estimate the global market for ink and overprint to be in the neighborhood of \$15 billion, according to Susan Anderson, a director with the management consulting firm The ChemQuest Group. North America and Western Europe each account for about 30% of the market, but printing ink sales have matured in these regions. China and India, however, are experiencing growth rates in printing of as much as 10% per year, as literacy, wealth, and manufacturing are all increasing in these countries.

Printing processes vary according to the type of substrate and end use application. Printing ink composition changes to meet the requirements of the process, substrate, and application as well. NAPIM identifies three main application areas for printing inks. Publication is the largest end-use, followed by commercial (advertising, brochures, etc.), and then packaging.

Offset or lithography inks are the major type of inks used in the U.S. These inks are typically highly viscous oil-based paste inks with a high pigment concentration. Very thin films are applied using offset blankets to transfer the ink from the litho plate to the substrate. The resins dry by oxidation or heat evaporation. About 98% of offset inks are solvent-based, with the remaining 2% energy-cured, using ultraviolet (UV) or electron beam (EB) technology, according to Steven Nerli, a consultant with market research firm Kusumgar, Nerli & Growney. The U.S. market for offset inks is estimated by Mr. Nerli to be valued at \$1.2 billion with an overall growth

rate of 1% per year. Energy-cured offset inks are leading the way, growing at 5% per year.

Web offset printing involves application of the ink to a continuous roll of substrate at high speeds, with some dried in ovens on the press and others drying through absorption into the substrate. News inks, for example, are absorbed into the substrates and use less expensive carriers such as mineral or soybean oil. With sheetfed offset inks, the resin undergoes crosslinking caused by oxidation. Metal deco inks are applied to beverage, aerosol, and other cans and require a high-temperature cure.

Demand for flexographic inks is growing at 3% per year and is currently valued at \$670 million in the U.S., according to Kusumgar, Nerlfi & Growney. With flexography, the liquid ink is dispensed by anilox cells onto a plate and then transferred to the substrate. Water-based flexo inks are typically used on Kraft, corrugated, lightweight news-type paper or polyolefin film and account for about 65% of total sales. Solventborne inks mostly find application on films, but are also used on some paper substrates. Radiation-cured coatings account for less than 1% of this segment of the inks market, but are growing rapidly at 6% per year.

Gravure inks are applied to the substrate via engraved cylinders. The low viscosity liquid inks are largely solvent-based (90%) and dry through evaporation. They are used for publication and packaging applications. This process tends to be used for longer-run applications. The total market in the U.S. is valued at \$570 million and is growing at 1% per year overall. Water-based gravure inks are experiencing an annual growth rate of 4% per year, according to Mr. Nerlfi.

Oil-based, letterpress inks have resins that dry via oxidation or absorption. They are viscous and are virtually all solvent-based. Use of these inks has been declining at about 2% per year in the U.S. Annual letterpress ink sales total about \$85 million.

Specialty inks include screen inks, inkjet inks, thermochromic and photochromic inks, and metallic inks. Screen inks are used in billboard advertising and labeling, among other applications. Inks used in screen printing for graphic arts are valued at \$25 million, with radiation-cured inks accounting for 60% of sales and growing at 5% per year. Use of solvent-based inks is declining in this application as well, according to Mr. Nerlfi. Sales of inks for screen printing of textiles are estimated to be \$14 million per year and growing at 2% per year.

Inkjet inks, which contain pigments or dyes, are applied directly to the substrate through a printer head. In the U.S., sales of inkjet inks total only \$130-133 million, but are growing rapidly at 9% per year, according to Kusumgar, Nerlfi & Growney. Waterborne inks

## Focus on Soy Ink

With the ink industry struggling to maintain margins in the face of ever rising raw material prices, alternative materials for inks are receiving increasing interest. As a renewable resource, soybean oil is one such material.

Soy inks have been on the market for coldset, commercial sheet-fed presses, and magazine heatset presses since 1989. About 25% of commercial printers in the U.S. use soy ink regularly. In 2002/2003, about 124 million pounds of soybeans were used for ink applications, with the oil coming from approximately 11,273,000 bushels of soybeans, according to Karen Andersen, director of marketing at the Iowa Soybean Association.

The largest application for soy ink is colored ink for newsprint. More than 90% of the 1,500 daily newspapers in the U.S. use soy ink. Not only is colored soy ink cost competitive to petroleum-based inks, but it is also environmentally friendly, provides more vibrant colors, good clarity, and offers superior rub resistance. The inks also offer an advantage in recycling because they are removed more efficiently from newsprint than petroleum-based inks. Traditionally, black ink based on soy oil has been more expensive than petroleum-based inks. With prices of petrochemical feedstocks skyrocketing, however, that may not remain the case.

In addition to newsprint, soy inks have been developed for several other applications. They can be used on coated papers, where they dry by oxidative polymerization. Heatset soy inks can be used for coated stock for magazines. Coldset soy inks can be used on web offset presses. Both waterborne and solvent-based flexographic soy ink formulations are available. Soy inks are ideal, though, for sheet-fed and coldset presses.

Recent research at the Coatings and Ink Research Institute at Northampton Community College has focused on utilization of soy products in radiation-curable inks. The work, which is funded by the United Soybean Board, is being conducted in conjunction with Lehigh University, which has made significant contributions to ink research over the past 50+ years. According to Jean Lavelle, who came from Lehigh and is now the director of the Institute, experiments have demonstrated that as much as 25% of the expensive acrylate oligomers in UV/EB overprint varnishes and lithographic inks can be replaced by inexpensive soy, a renewable resource. "In most systems, the modified soybean oil actually decreases the amount of UV energy required for cure," she notes. For EB, though, the soy products usually do not affect cure response positively or negatively.

Other benefits provided by the use of soy products in printing inks include film flexibility, adhesion to non-porous substrates, pigment wetting, reduction in the acrylate odor, and enhanced printing performance of lithographic inks. Preliminary experiments indicate that these soy products can also be beneficial in UV-curable flexographic inks.

## Leading U.S. Ink Manufacturers

Sun Chemical  
Hunt Group  
INX International  
CR/T  
DuPont Ink Jet  
CCI/Siegwerk

## Leading Global Ink Manufacturers

Dainippon Ink & Chemicals (Includes Sun Chemical)  
Hunt Group  
Toyo Ink  
Siegwerk Group  
Huber Group/Micro Inks Ltd.

dominate with a 65% share of this segment, but they are growing at 7% per year, while solvent-based inkjet inks are growing at 10% per year. Hot melt and radiation-cured inkjet inks account for a very small percentage of this segment, but are growing at 15% per year.

The success of inkjet inks has attracted many players to this segment of the market, and as a result margins have declined somewhat. Many ink manufacturers have become involved in developing complete systems to maintain their advantage, and have found that partnerships with OEMs or printhead manufacturers is almost a necessity for success. For example, SunJet, a division of Sun Chemical, in cooperation with Inca Digital Printers, recently launched FastJet™, a four-color digital press utilizing arrays of fixed printheads for very high-speed printing on corrugated substrates. Inkjet inks have gained ground in most printing ink markets, but the greatest success has been in screen processes. Significant potential has been identified by industry players in labels and packaging and small niche applications where shorter runs are required.

Thermochromic and photochromic inks change color when exposed to heat or light, respectively, and are used in packaging applications and for sensitive documents. Metallic inks are attractive in consumer packaging where they are designed to differentiate products.

Radiation-cured technology finds use in the various different printing ink processes. Applications can be found in flexographic and offset printing for both food and non-food packaging and commercial/publication where appearance, environmental regulatory compliance, and productivity are important. With ultraviolet (UV) inks, UV lamps cause photoinitiators in the ink formulation to cure the resin. They are attractive in various packaging and screen printing applications. Electron beam (EB) inks are cured by electrons and are attractive in food packaging applications because they contain minimal extractables and have minimal odor. Most importantly, all are web-based and permit high-speed reproduction.

These inks tend to possess excellent gloss and resistance characteristics and exhibit strong graphic impact.

Quick curing times are the biggest benefit offered by radiation-cured inks. The reduced amount of energy needed for this technology and the fact that these ink formulations contain no volatile organic compounds (VOCs) are also attractive features. "We fully expect there will be a continued growth of environmentally friendly technologies, primarily energy curable products with zero VOCs and hazardous air pollutants (HAPs) that allow ink makers and converters to operate with greatly reduced environmental risks and regulatory concerns," states Michael Kucharski, marketing manager—Graphics, Americas, with Cytec.

However, radiation-cured inks do currently face challenges including lack of compliance with FDA food contact regulations, raw material handling issues, odor, adhesion to substrate problems, consistent coating weight across wide webs in flexo printing, perceived cost disadvantages, and line speed, according to Ms. Anderson. "As these challenges are met, it is expected that UV and EB technology will replace water-based inks, particularly in packaging, as well as solvent applications," she notes. Recent advancements in improved adhesion, lower odor, and hybrid cure are being made, which is opening new opportunities for the technologies, and she expects they will grow at a rate of 6% or more per year from a relatively small base for the next several years.

Waterborne technology has captured a strong position in flexographic processes on paper and film, gravure on paper, and in overprints. However, the average growth rate for water-based printing inks has declined recently as many of the applications that use this technology have become commoditized, according to ChemQuest. Potential for growth does still exist for some applications, including sleeves for packaging, food packaging, and labels. In addition, Ms. Anderson also believes that, in flexible packaging, new developments in substrates primarily aimed at raising the surface tension are expected to spur the changeover from solvent to water in years to come.

Solvent-based technology dominates publication gravure, and a large portion of the packaging gravure ink market has remained solvent-based. Use of solvent-

borne inks is declining, though, in flexographic printing applications. "Adhesion to flexible packaging, aesthetic quality, and slower line speeds continue to be challenges for waterborne inks," Ms. Anderson says. Many printer/converters have installed solvent recovery systems and are therefore unlikely to switch to waterborne technology.

## INDUSTRY PLAYERS AND CONSOLIDATION

The leading players in the printing ink industry offer products and technologies for all printing processes and end-use applications. Smaller players tend to specialize in one or two areas only. Dainippon Ink & Chemicals/Sun Chemicals dominates the global printing ink market as the clear leader, with \$4.9 billion in worldwide sales. Flint Group holds second place, a position it recently made much stronger with the merger of XSYS Print Solutions and Flint Ink Corporation. Flint Group's estimated sales for 2005 were \$2.71 billion. Toyo Ink is the third largest player, followed by Siegwerk and Huber Group/Micro Inks Ltd. These top five companies account for at least 70% of the total market, according to Ms. Anderson.

The merger of XSYS and Flint, which was finalized in October 2005, is the largest of many recent consolidation activities in the printing ink industry. CVC Capital Partners, which acquired BASF Drucksysteme and ANI Printing Inks to form XSYS in late 2004, owns the new entity created by this merger. About 50% of the new company's sales will be in Europe. Siegwerk acquired the packaging ink business of SICPA in June 2005 and, according to the company, is now the second largest global player in this segment of the industry. SICPA has become a smaller, leaner company focused on the security ink market.

The third major consolidation event in the ink industry revolves around the alliance between the Huber Group, the fifth largest printing ink manufacturer, and India's Micro Inks Ltd. Huber Group has announced plans to acquire a majority stake in Micro Inks. This transaction is expected to be completed early in 2006. With the acquisition, Huber will

become a more global company and will also gain backward integration into resins and pigments.

In the digital ink sector, Fuji Photo Film Co. (Fujifilm) acquired Sericol, the world's largest producer of screen printing inks, in early 2005. Fujifilm also announced in December 2005 that it has agreed to acquire Avecia's inkjet business for \$260 million (Euro 219 million), with the deal expected to close in February 2006. In June 2005, Dainippon Screen acquired Inca Digital, which has alliances with both Sun Chemical and Sericol. Jettron LLC was launched by Flint Ink Corporation in 2003.

Consolidation has also occurred among resin suppliers, with Cytec Industries acquiring UCB's Surface Specialties business in October 2004, and DSM purchasing NeoResins in February 2005. On the additives side, Altana Chemie purchased Eckart GmbH, a leading producer of metallic effect pigments and metallic inks.

"Globalization and consolidation by both ink companies and their customers is creating a changing competitive landscape," notes Rita Conrad, vice president of corporate communications for Flint Group. According to Michelle Moss, industry manager with DSM NeoResins, this globalization results in a trend for ink production to move to lower production cost regions, outside of the U.S., such as Latin and South America, India, and China, for example. "The China effect will be the biggest challenge in the coming five years, both as opportunities to supply resin into this market and as a threat. As resin and ink production in China increases, there will be a rise in exports into U.S. markets. The same can be expected for even the printed stock. More and more ready made printed packaging



Photo courtesy of Sun Chemical

will be imported from countries with low labor costs," she says.

"The consolidation is expected to continue due to the extreme pressure on margins that has been inherent in the industry and now has increased to painful levels with the accelerated climb in raw material prices," Ms. Anderson notes. She adds that consolidation of ink companies, particularly the acquisition of smaller firms by larger players, allows these industry leaders to increase their buying power across the various market segments they serve. Consolidation among customers of printing inks will also continue to place pressure on the industry to reduce its fragmentation.

On the positive side, consolidation may create opportunities for smaller players in the ink market. "The ink industry will be even more consolidated than before, but will allow more room for small companies that specialize in niche products. The same will hold true for the converters," notes Bill Bayer, business director Radcure, Americas with Cytec. Overcapacity at the formulator end should be reduced, both through the consolidation and as a result of plant closures and companies leaving the market. "The industry has excess capacity and there are a number of smaller, privately-owned companies whose family owners may be looking to exit the business," comments Michael Griem, president, Sun Chemical North American Inks.

Many of the recent ink industry acquisitions involve private equity firms in Europe taking ownership of U.S. businesses. "The purchasing of U.S. ink companies is coming from investor groups who are consolidating regional companies into global groups," says Mr. Griem. "This does not necessarily remove capacity from an overburdened market. However, you would think these investors must be pretty savvy and are expecting a reasonable return on their Euro. Of course, competition is likely to heat up, but that may be based on important factors like multinational supply and local service rather than pricing."

## UNIVERSAL CHALLENGES

No matter what type of ink technology or end-use application ink producers are targeting, they all are facing similar challenges in the marketplace. Most components of printing inks are derived from petrochemicals, and rising oil prices have pushed raw material costs for resin, pigment, and additive suppliers and their ink manufacturing customers to unprecedented levels. Shortages of some key raw materials, particularly acrylics and esters, have added to the difficulties.

"Ours is an industry based on petrochemical derivatives. No market segment is immune, and most major ink suppliers have recently announced price increases

and/or surcharges to help offset the burden," says Ms. Conrad. "Other print suppliers have felt the effects as well, and costs have increased for paper as well as other supplies. Since price increases on inks had not been implemented in many years, the change met with some resistance. However, some printers that participate in multiple links of the printing supply chain, i.e., both selling and printing/converting substrate, have raised prices themselves. Even end-users cannot ignore the impact," she continues.

Like ink makers, many printers in all segments of the industry are operating with narrow margins as well, notes Mr. Griem. Consequently, many have resisted supplier price increases. "However, the evidence of the rising raw material costs and the poor availability of many key ingredients is clear, and most printers are accepting the ink price increases which have spread across the industry," he adds. "At Sun Chemical, the fact that we are an integrated supplier has helped us to ensure a steady supply to our customers." Investment in research and development to find competitive alternatives for key ingredients in short supply due to rising costs or a shrinking supplier base is also key to success for ink manufacturers, states Mr. Griem.

They have found it necessary to pass on price increases to ink manufacturers regarding resin producers, in order to achieve reinvestment economics. As a resin supplier to the packaging inks sector, DSM NeolResins has been able to maintain growth levels in an overall flat U.S. ink market, according to Ms. Moss. "The increasing costs we are experiencing are applied across the full supply chain from the cost of raw materials for resin production to the formulated finished inks. The controlling factor is the cost of oil and gas, and we have little influence on this aspect. Our raw materials are increasing significantly, and as such we have had to pass these increases onto our customers. Likewise we see our competitors and our customers increasing prices too," she notes.

Additive suppliers have been forced to raise prices under these conditions as well. Huber Engineered Materials (a separate company from the Huber Group) provides treated and untreated kaolin clay to ink manufacturers around the world. "We have raised our prices up to 15% due to increased costs," states director of kaolin product development, Shaw Gilmer. "We have also implemented energy surcharges on water washed and calcined clay based on the spikes we have experienced since the hurricanes hit the Gulf of Mexico."

Recovery in the Gulf is not expected to return prices to pre-Katrina levels, either. "Even with the chemical industry moving closer to post-hurricane operations, business is not back to normal. This is still causing disruptions in the supply chain," says Mr. Bayer. All segments of the ink industry are affected. "It truly doesn't

matter because every segment is involved in the same supply chain. Higher costs and the uncertainty of natural gas supplies and transportation are tied into every step from manufacturing to delivery to the customer," he explains. "At Cytec, we're always working to optimize our value proposition to customers. This involves continuous improvement in our key processes and cost control. However, despite our best commitment to improve our costs, we have had to pass along price increases to our customers."

Additive and resin suppliers are working closely with ink manufacturers to develop lower cost alternatives that still offer the performance necessary for high quality inks. Currently, resin manufacturers are concerned that many refineries will divert feedstocks needed for resin production into the gasoline market because they can get a better return with fuel prices at such high levels. "As a relatively small user, the ink industry has limited bargaining power," notes Ms. Conrad. "For example, the tire industry is in a much better bargaining position on carbon black than we are." A shortage of acrylic acids is also an issue, particularly for radiation-cured inks. Increased demand for these compounds in super-absorbent materials used in disposable diapers, for example, has left supply extremely tight.

For the publication ink segment, these raw material issues are not the only concerns. "Growing competition from electronic media (particularly the Internet), increasing postal rates, and the movement of manufacturing and printing to lower cost regions are additional challenges," says Ms. Anderson. The packaging segment has fared better, as consumer product companies have turned to novel packaging as a way to differentiate their products from those of their competitors.

Flexible packaging is the main area of growth in the packaging segment. Retort packaging, where food is cooked in the packaging itself, along with shrink sleeves, stand-up pouches, and pharmaceutical packaging, all offer considerable opportunities for growth. There has been a shift to flexographic printing processes from gravure for these applications because flexo offers improved graphics, lower costs, and is more appropriate for shorter print runs. Digital printing (inkjet inks), however, is expected to take some market share in this area. Paper packaging in the U.S. has declined due to offshore competition. As much manufacturing of goods that require packaging moves to low cost region, it is expected that packaging operations will follow as well.

## INNOVATION IS KEY

In such a highly competitive environment, printing ink manufacturers need to find ways to help their customers differentiate themselves. "Inks play a key role in

## Fade Resistance of Lithographic Inks

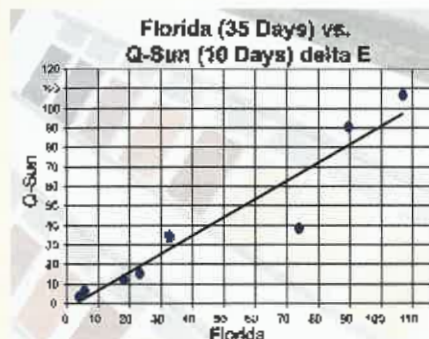
The Graphic Arts Technical Foundation (GATF) and Q-Lab Corporation (formerly Q-Panel Lab Products) have released a landmark study that for the first time establishes correlation between real-world and accelerated lab exposures for lithographic inks. Lithographic inks are used in a wide range of printing applications, from commercial to fine art, and their service environments vary greatly as well. Through this study, labs can now better assess the durability of their printing ink specimens.

The study included Florida and Arizona under-glass exposures, as well as Q-Sun xenon arc laboratory exposures. Florida and Arizona under-glass exposures comprise "worst case" environments, with high UV, high temperature, and high humidity. By including Q-Sun testing in the program, correlation between natural and accelerated results was obtained.

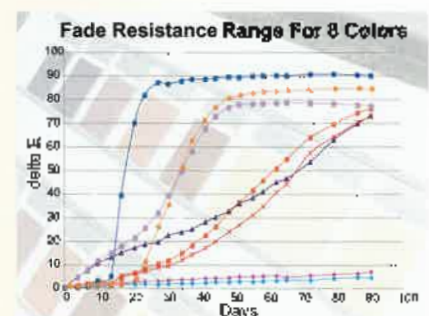
The GATF technical staff chose eight different pigments for under-glass exposures. After 35 days, the inks exhibited a wide range of fade resistance, ranging from excellent to poor. After 90 days, the majority of test specimens were severely faded, and no longer useful for analysis.

A comparison of the 35-day evaluations from both locations shows excellent rank order correlation between Florida and Arizona. Both locations provided fast and effective results that separated the pigments with excellent fade resistance from pigments with poor fade resistance. Another interesting discovery is that in this series of tests, the time of year did not make a difference in the ranking performance of the inks. Seasonal variability only makes a difference in the speed of degradation.

The Q-Sun tests included both controlled and uncontrolled relative humidity. A comparison of the two environments showed excellent correlation, with a rank order coefficient of 0.98. This demonstrated that humidity made little difference in the ranking of specimens, which allows use of less costly xenon devices to run similar tests. For more information, contact Q-Lab Corporation at 440.835.8700.



Correlation between Q-Sun Xenon Test Chamber ink exposures and Florida under-glass exposures.



Testing revealed a wide range of durabilities in the inks, with fade resistance ranging from excellent to poor.

many of the new technology developments that are emerging in the printing industry," says Mr. Griem. Stochastic screening enables the production of high quality printing even on lower-grade stock. Higher strength inks provide equal densities with use of less ink. New prepress techniques also make it possible to consume less ink. Some ink manufacturers have developed formulations suitable for multiple substrates, so printers need to keep fewer inks in inventory. The key for ink producers is to provide new technology that offers new effects along with high performance, and all at lower cost. Other new product areas for ink producers include RFID, color management, and product security. "These developments are being pushed by brand owners who want to increase and protect their brand equity," Mr. Griem notes.

A combination of innovation and service is the key to success. "Focusing on improving the short term situation is a necessary action, but for the longer term further innovations are required to stay ahead of competition," says Ms. Moss. "Innovation will fulfill a need where there is currently no suitable answer available." As globalization continues, DSM NeoResins has also organized its business to meet the needs of global supply, with production facilities located in the U.S., Europe, and China, states Mr. Moss.

"Determining how the market and competition will sort itself out, and staying ahead of the curve on all fronts will be important for achieving success in the inks market," adds Mr. Bayer. "The question facing everyone in the industry is the same: How/where do you best invest in technology/innovation as costs continue to escalate, customers squeeze suppliers, and, in some cases, seek commoditization of products as short-term solutions? Regardless of these challenges, creating advanced technology solutions for our customers is fundamental to us. We're developing next generation technologies that can help our customers address their needs and grow their markets."

A balance of modest and step-change innovations are also important. "Many times the most marketable innovations are evolutionary, not revolutionary. The former are often more easily adopted by the customer base," explains Ms. Conrad. "Still, far-reaching innovations are also important to continue making this industry more efficient as well as continuing to keep print materials on the map as an important marketing tool. She adds that as the balance of conventional ink-on-paper vs. digital vs. electronic media continues to shift, industry manufacturers must look for new ways to grow sales in a mature market.

"Supplying printers with the value-added resources they need to be competitive is critical," Mr. Griem emphasizes. "We invest heavily in research and development, and rely on our technology group to provide us with innovative products that give Sun Chemical a competitive advantage. In addition, we also focus on providing a superior level of local technical service, timeliness, and global perspective to our customers."

There is no doubt that the players in the ink industry will continue to face challenging times. "Whether it's due to economic conditions or increasing competition from new media, print will just not grow as fast as it has historically," says Mr. Griem. "Print won't disappear any time soon, but stagnation will likely force more printers and their suppliers to either fold or consolidate."

Those companies positioned to participate in growth segments such as radiation cured inks and digital technology will do well. Others committed to more mature sectors of the ink market such as publication inks will need to rely on cost reduction, innovation, and value-added services to sustain profits in the face of growing competition. Whether an ink manufacturer or resin or additive supplier, managing the supply chain and pricing issues will remain at the forefront of activities for all companies involved in the ink industry. 