

WILL CHINA AN PHOTONICS

The latest challenge facing the optoelectronics industry may turn out to be more than the typical technology market demands for “smaller, brighter, and faster” products. New requirements emerging from Europe and Asia are challenging companies to design more environmentally friendly products. As these regulations take hold, the industry will probably need to add a new buzzword—“greener”—to the list of market demands.

Lead-free optics: A tale of two companies

Despite the fact that optics are exempt and that the impact on the environment is minimal compared to solder in electronics equipment (lead oxide in glass does not tend to leach out into the environment the way lead in solder alloys does), both Olympus and Schott are already producing many lead-free optical products. In addition, both firms have company-wide, top-down overall environmental initiatives that address the phase-out of hazardous chemicals, manufacturing waste products, and the monitoring of energy use and CO₂ production.

According to Larry Wang, vice president of Olympus Partnership Development Group, his company was addressing these issues long before its lead-free optics release earlier this year. Olympus has an environmental task force that meets to

DO JAPAN LEAD LEAD-FREE?

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New regulations in Europe and directives in Asia are requiring electronics equipment to be free of certain hazardous substances and, although large portions of the optoelectronics industry will be legally exempt from the European Union (E.U.) legislation, many companies will likely be unable to ignore the market influence of the proactive Asian response to these emerging demands for “greener” products.

The European Union Directive 2002/95/EC (Restriction of Hazardous Substances in Electrical and Electronic Equipment, also known as the RoHS) establishes environmental regulations requiring the elimination of six hazardous substances from electronic products by July 1, 2006. These chemicals include lead (most frequently used in solder), mercury, cadmium, chromium, polybrominated biphenyl, and polybrominated diphenyl ether (flame retardants). Europe also passed the Waste Electrical and Electronic Equipment regulation (WEEE), which requires electronics manufacturers to reclaim and recycle products after their useful lifetime. Optics and optical components will likely not be included in the European RoHS. Exemptions have been made for optics and also for major optoelectronic applications such as defense, medical, and telecommunications.

Nonetheless, China and Japan are acutely aware of the changes and are actively preparing for the coming E.U. legislation. The Chinese government is planning its own Regulation for Pollution Control of Electronics Products (RPCEP), which would require mandatory compliance with the E.U.’s RoHS by July 1, 2006. According to Michael Liu of China Outlook Consulting (Calgary, Canada), the Chinese government is working on directives that match or exceed the E.U.’s demands, and all manufacturers in China and those selling into China will be forced to make adjustments. The government is outlining steps to compliance and releasing lists of products (20 at a time) that must comply—companies producing these products then have one year to meet the new requirements.



FIGURE 1. At the JDS Uniphase clean room in Bloomfield, CT, an assembler attaches optical fibers to the internal optical components of a modulator for use in telecom amplification. Such components will become RoHS-compliant according to the company.

estimate, the increased cost to manufacture printed-circuit boards and other electronics can be as little as 3%; but for Chinese manufacturers with profit margins of only 5%

Such changes are not always straightforward. Simply replacing current solder with lead-free solder, for example, will not be enough. Physical changes brought on by a change in soldering materials mean manufacturers must requalify their products with the new lead-free alternatives. In some cases, government officials

to 10% this increase is significant. Even so, Chinese manufacturers are aware that eco-friendly products are the wave of the future and don't want to be locked out of the market. According to Liu, about \$200 billion of electronics were produced in China last year, with about one-quarter of the total (\$50 billion) exported to Europe.

Producing an eco-friendly product

Extensive reengineering may be required to bring a complex optoelectronic system such as a camera into compliance with emerging "green" regulations. Besides the elimination of lead from circuit boards and optical components, mercury must be eliminated from flat-panel displays, and any plastic enclosures must be free of the flame retardants, polybrominated biphenyl and polybrominated diphenyl ether. Durable metal casings for the final product (such as are used in some laptops, for example) must also be engineered to eliminate the hexavalent chromium coating that currently provides a self-healing scratch-resistant capability. Clearly, the impact of eco-friendly regulations can be such that sometimes a product redesign "from the ground up" is a more cost-effective solution than reengineering an existing system.

Main eco-product features

- Use of lead-free lenses:** Lead-free lenses are used for all types of optical lenses and prisms.
- Use of lead-free coating:** Lead-free coating with In and Zn is used for major electrical circuit boards.
- Mercury-free backlight source for liquid-crystal displays:** A white LED is used for the backlight source of liquid-crystal monitors to save energy and minimize mercury.
- Resource saving, using secondary batteries for power supplies:** Resource-saving lithium-ion batteries are rechargeable 500 times.

OLYMPUS

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formulate a five-year initiative for plans and policy that is reviewed by the president every three years. This initiative started before 2000. Its goal is to initiate eco-friendly products, evaluate all parts, materials, and manufacturing methods and replace hazardous components with "green" parts either purchased or designed internally.

In Japan, producing environmentally friendly products is not legislated, but is instead a business philosophy. Company-wide training for all managers is required at Olympus, and internal corporate communications carry the slogan "Smile for the Earth." So, for example, in addition to the chemicals outlined in both the China and E.U. initiatives, Olympus has removed xylenes, ethylene glycol, nickel, and other toxics from its production and manufacturing, and plans to phase out all chlorine-based solvents by March 2006. The company is striving for zero-emissions facilities, and currently monitors all emissions. In fact, according to Wang, Olympus has reduced its energy use and CO₂ production (unit consumption/production to sales) by 28% in the past year alone.

Olympus, a 90-year-old company, did not turn its back on its older manufacturing facilities—instead they were decontaminated (including toxic-waste removal) and upgraded to meet current environmental standards. Although the company does OEM some electronics, it typically makes its own printed-circuit boards in China, with lead-free solder for some electronic boards. A producer of optics, lenses, binoculars, microscopes, cameras, and many other products, Olympus showed with the release of its new lead-free aspherical lens at Photonics West (San Jose, CA) in January that products redesigned to be environmentally friendly can actually provide better performance.

"Lead was traditionally used in glass to change its physical properties, such as the melting point of the glass," said Peter Wang, optical-product manager at Olympus. "With lead-free glass, Olympus has shown we don't have to sacrifice quality for eco-friendly lenses."

Schott has developed a similar philosophy. With factories in the United States, Germany, and Malaysia, the company has a commitment to making lead-free optics and removing heavy metals not just from the final optical components but also from manufacturing byproducts. The company has a 5000-ton capacity for optical glass, of which only 260 tons have any lead oxide in them, notes Alexander Hagemann, executive vice president of Optics for Devices at Schott Glass. Exemptions exist for products such as defense or special applications, and Schott has said that it is phasing out lead in all products except glass for radiation shields. (Glasses used in nuclear power plants and nuclear waste-treatment plants contain about 70% lead oxide because it is currently the only technology that provides transparency while shielding against radiation).

Furthermore, because lead dust is a byproduct of optical production and is more likely to leach lead into the environment than the actual optical component, Schott also requires its manufacturing facilities to reduce pollution of all types including reducing energy use and CO₂ production. In fact, with a business of more than \$200 million annually in the production of glass, ceramics, filter glass, prisms, and components from the Optical Glass and Components division alone, there is a clear business commitment from Schott to make high-performance eco-friendly optics.

"This is all part of our business and mission statements," Hagemann said. "We have four facilities worldwide, and we aren't content to simply outsource to a location with lower labor costs, and less stringent environmental regulations [such as Malaysia]. We make sure all our facilities are adhering to the highest environmental and technical standards."

While it is unclear whether Japan will require the same level of compliance, the Japanese government has been working closely with its manufacturers to encourage Japanese industry to be proactive in its response to environmental trends; as early as 1998 Japan began increasing levies for recycling electronic equipment with lead. Some Japanese firms have already responded to internal and external market pressure for more environmentally friendly products. Olympus (Tokyo, Japan), for example, recently released a complete line of lead-free optics and has implemented its own company-wide environmental plan (see "A tale of two companies," p. 110).

Impact on optoelectronics

Telecom and the smaller optoelectronics components are one of the gray areas in these environmental directives. China will be producing eco-friendly electronic products in compliance with its RPCEP requirements, but there is currently no talk of making these "green" directives directly applicable to the optics and optoelectronics assembly markets. Some components manufacturers believe the new regulations will primarily affect smaller electronics. David Rossi, director of marketing at Newport-Spectra Physics (Irvine, CA), says that the new European regulations are geared more for products like the Sony Walkman and Gameboy—relatively inexpensive, small,

and disposable devices that are mass-produced and have short lifetimes.

"Large-scale laser systems will be exempt because they are produced at a much smaller volume and their lifetime is more like five to ten years as opposed to a Gameboy, which has a lifetime of six months to a year," said Rossi. "Newport and Spectra-Physics are currently compliant through 2006, and we are working closely with our European operations to ensure that we continue to be compliant thereafter."

The lead-free and other environmental initiatives, however, are still likely to have a dramatic effect on the optoelectronics components industry. The most obvious will be in the lead-free soldering of printed-circuit boards.

However, given that the optoelectronics industry, for the most part, purchases its computer-control components from OEMs, lead-free solder will be less of a development issue than the actual optics. The optoelectronics industry will benefit from the advances put into place by developers of home electronics, semiconductor, and computer manufacturers, and will easily be able to purchase compliant printed-circuit boards.

Although the Chinese RPCEP is not yet law, it closely follows the E.U.'s RoHS directive. Furthermore, the E.U.'s WEEE directive requires that products be completely recycled by the supplier. If optoelectronics suppliers and sys-

tems manufacturers are held to those standards, all aspects of their products would have to be reevaluated in terms of both banned toxic chemicals and the ability of suppliers to recycle or reuse all or parts of their systems.

Beyond the regulations

While the E.U., Chinese, Korean, and Japanese governments are all working with their industries to help them make the necessary changes, the United States government seems to be ignoring the issue, according to one optoelectronics manufacturer, who noted that the optical components and telecom industries will likely feel a negative impact from this inaction. Most optoelectronic-component vendors currently sell at or below cost, and requalification of a telecom product is expensive—up to \$500,000 in some cases. Even if a company is just replacing traditional solder with lead-free alternatives, if a product has to be redesigned or requalified to be sold under the new environmental regulations, those companies with small optoelectronics components, low margins, and low volumes just can't compete with companies with high-volume electronics, such as those in China.

Some U.S. components manufacturers are already prepared, however. JDS Uniphase (San Jose, CA), which produces many products in China, is well aware of the upcoming environ-

mental regulations and has already put into place a plan for eco-friendly design and manufacturing, says Randall Sutherland, senior manager for public relations. In addition, its business units are required to allocate a portion of their budgets for manufacturing changes or redesign costs that will be necessary to keep their subassembly

products compliant (see Fig. 1).

This strategy is likely to pay off even if optics and optoelectronics components are exempted from the new regulations. If China and Japan continue to respond to environmental trends, the worldwide photonics industry may soon find itself in a market that demands eco-friendly products. Asian companies will be a

market force driving other companies to match or exceed their capabilities.

And exemptions are another difficult issue. "Even if a company wants to sell a product under exemption, they can't apply to the E.U. for a general exemption," said Pamela Gordon, an analyst with Technology Forecasters (Alameda, CA) and author of *Lean and Green: Profit for Your Workplace and the Environment*. "They have to apply for exemption for each individual country within the E.U., and it is likely this will become a competitive issue. If another company develops a comparable product that is compliant, it is likely the E.U. will remove the exemptions." Obviously, the time and resources necessary to apply for individual exemptions would be costly to a company, especially if it eventually finds itself locked out of the market by a competing product that's compliant.

If the optoelectronics industry suddenly found itself facing the same requirements as the electronics industry, many changes would need to take place. Optics, crystals, optical components, systems, and optoelectronic cases (the box the laser sits in) would all have to comply with the hazardous-substance legislation (see Fig. 2). In this new eco-friendly scenario, according to Gordon, the conventional manufacturing model of "sell and dispose" would no longer be effective. Business would probably begin to modify product designs so that systems can be reused and upgraded to delay having to recycle. They would then have to rework business and inventory models to accommodate inventory tracking and recycling of systems and parts.

"Most likely this would lead to new business plans, including leasing some systems rather than selling them," Gordon said. "Leasing of equipment was much more common 20 to 30 years ago, and there are numerous business benefits to doing so, including more-accurate projections of revenue streams, staying in closer touch with customers, and increasing brand loyalty." In the long run, the new regulations would prompt many companies to reevaluate and rationalize whole product lines to decide which products to redesign for the market and which to simply discontinue.

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Regardless of the company or product produced, the influence of new environmental regulations and the proactive Asian environmental initiatives will likely push optoelectronics producers to reevaluate their engineering design, production methods, and environmental commitment. Customer demand for “green” products, not necessarily legislation, will shape the market. Thus, even today, when optics are exempt from RoHS, its influence is being felt, according to Devaunshi Sampat, vice president of sales and marketing at Laser Optics (Northvale, NJ), which is owned by Photonics Products Group. “We aren’t being impacted directly; however, we have seen that some of our customers are affected,” she said.

The E.U.’s regulations seem to be a driving force for the directives in China and the initiatives in Japan and the optoelectronics industry is already making optical components to meet these standards. While the optoelectronics industry is exempt, so far, from meeting the Asian standards, it is clear the Asian “green revolution” is being felt. □

FOR MORE INFORMATION

RoHS and WEEE directives, FAQ’s and an interactive self-assessment to determine if your product is exempt: www.pb-free.info
China Outlook Consulting:
www.china-outlook.com
Technology Forecasters: www.techforecasters.com
Lead-free solder: www.metallurgy.nist.gov/solder
Lead-free optics: www.us.schott.com/optics_devices/english/download/ (click on TIE34: RoHS Annex).
Conferences and training courses: www.ipc.org and www.JEDEC.org

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