Future Outlook For The Photonics Industry

Experts from leading photonics organizations discuss what is next for this ever-changing industry and what they are doing to keep up.

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The photonics industry adapts with whatever technology is taking off at the time and even stays ahead of the innovation of the moment. As the newest features in optics are released and admired, new discoveries are made elsewhere that will trump today's phenomenon. It is this constant growth and development that makes the photonics market both marvelous and mysterious. While the future of photonics is uncertain, industry experts do their best to predict what is next for the industry and keep ahead of the curve.

3CCD Technology

By Toshiba Imaging Systems Division

As the amount of applications the photonics industry serves grows, the amount of imaging solutions designed for those applications subsequently increases. Because of this growth and development, the photonics marketplace has become packed with CCD and CMOS camera offerings that are readily available for practically any application from various manufacturers. Camera options are innumerable with custom versions or off-the-shelf solutions. Variable features such as speed, resolution, and output give the end user a plethora of camera performance options. The task of choosing from this abundant supply can be daunting; and, it is the manufacturer's job to predict the future needs of the photonics industry and choose an area of developmental focus.

The scientific imaging, broadcast, factory automation, and industrial video markets are finding huge advantages to using 3CCD (i.e. three-chip) technology in diagnostic equipment. Although the applications requiring 3-chip color camera technology are far less demanding than the traditional single-chip cameras, they are gaining popularity in these vertical industries. The color information provides a tremendous amount of data that cannot be recognized with single-chip cameras.

In the laboratory, pathologists are viewing human cells and tissue with more color accuracy than ever before, giving them a new advantage in their life-saving work. In sports television, as well as the reality TV craze, the broadcast market is seeking out 3CCD remote color cameras for head-cam shots. These color, 3-chip CCD cameras produce much better color fidelity compared to single-chip color cameras, and the reproduction quality is essential to this application. It is critical

Figure 1. The red, green, and blue information is interpolated across several adjacent cells to determine the total color content of each individual cell.

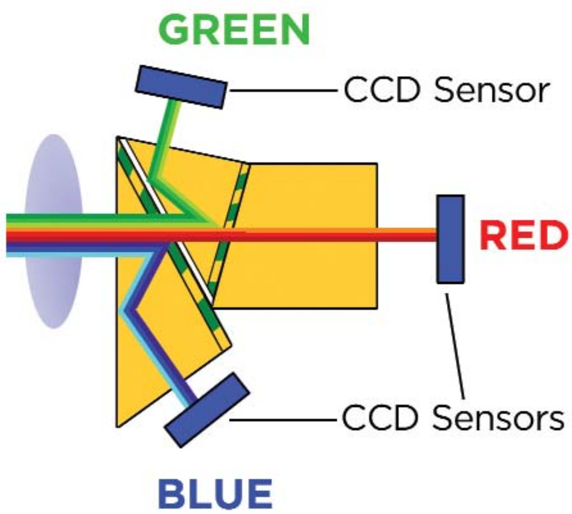

FIGURE 2. 3CCD CAMERAS CONTAIN THREE SEPARATE IMAGE SENSORS AND A PRISM WHICH DIVIDES THE INCOMING LIGHT RAYS INTO THEIR RED, GREEN, AND BLUE COMPONENTS.

for the color imagery to look similar to the quality of the high-end broadcast cameras.

Even a small percentage of applications in the factory-automation market require 3CCD technology. For the inspection of print quality on CDs and other such labels, the three-chip color CCD technology provides the high-quality imaging that is necessary to produce the best quality labels. Additionally, the industrial-video market, which includes non-destructive testing and even high-end security applications, is beginning to see the distinct advantages of precise color reproduction with 3CCD cameras.

There are far fewer 3CCD camera manufacturers than there are single-chip suppliers in today's market. The technology is much more specialized, and thus, more expensive. Single-chip area scan cameras use a single sensor covered by a color filter with a fixed, repetitive pattern. To reconstruct a complete color image, an interpolation is needed. The red, green, and blue information is interpolated across several adjacent cells to determine the total color content of each individual cell, therefore providing less color accuracy than 3CCD (see figure 1). 3CCD cameras contain three separate image sensors and a prism which divides the incoming light rays into their red, green, and blue components. Each chip then receives a single color at full resolution, therefore providing the best color accuracy available (see figure 2).

Currently, less than 1% of the video cameras sold in the photonics market are 3CCD color cameras. This number is expected to grow as this technology becomes more affordable and advances in high-definition (HD) technology bring it to the next level.

Infrared Imaging Technology

By SUI, part of Goodrich Corporation

The photonics industry, which once catered to only highly scientific and technical demands, has expanded to include imaging products that serve the demands of the average consumer. Consumers now have high definition video cameras for capturing family moments and mobile phones featuring integrated cameras. With the advances in camera development and image processing, the presence of imaging technology is ubiquitous in today's world. And now, even infrared (IR) imaging technology, which was once reserved for use in scientific and military markets, has entered the non-military market space. With higher volume production of IR imaging products and lower pricing, this technology is finding new, consumer-based and more commercial-based applications. Firefighters are using IR imagers to help find people in burning buildings, police have them on helicopters to apprehend suspects on the run, and consumers are renting them to find insulation leaks in their homes.

Shortwave infrared (SWIR) or near-infrared (NIR) imaging is a growing industry driven by the advances in indium gallium arsenide (InGaAs) detector technology and the subsequent lowered costs to produce this higher quality imaging material. Improvements in InGaAs cameras, such as increases in resolution and sensitivity have been accomplished, while at the same time, overall pricing has been dramatically decreased in the last five years. InGaAs SWIR cameras are now at one megapixel resolution and capable of imaging at night under starlight-only conditions with room temperature arrays. The high resolution arrays are available in both linear and 2-D formats. The new high speed capability for SWIR imaging allows for many machine vision applications such as glass bottle inspection, agriculture sorting, plastics sorting, spectroscopy, and metals manufacturing. Since the SWIR cameras can use standard glass optics, this has opened the doors to many industrial manufacturing applications where thermal cameras have difficulty because of their expensive, exotic optics and their need for sapphire or germanium protective enclosures. Each day new applications are being discovered where SWIR can sort and identify objects that cannot be easily differentiated in the visible wavelength band.

With advances in Si imaging technology allowing for more image processing on-board the cameras, the new, smart SWIR cameras will become even more prevalent in industrial applications. The number of pixels will most likely not grow beyond high-definition resolution except in some specialty military and astronomy applications, but the pixel pitch will be shrinking from the commercial standard of 25µm to 15µm or even 10µm in the next few years. The sought-after larger arrays will require very large optics if the pixel pitch does not decrease in size. The military will likely be at the forefront of this technology push and the consumer market will again reap the benefits of the technological advances.

New machine vision tasks, the telecommunications industry, and expanding medical imaging applications will also drive the prices of imaging components and arrays lower as their quantities continue to increase. This exciting growth will give rise to yet-unidentified applications as new markets continue to sprout based on higher production yields, subsequent lower prices, and the advances in photonics research and imaging technology.

Shortwave infrared camera systems and near-infrared detectors and arrays can perform a variety of SWIR imaging tasks for machine vision, medical, spectroscopy, military, agricultural, commercial, and telecommunications applications.

High Speed Camera Technology

By Photron, Inc.

The high speed video industry is forever in a state of flux. Beginning with the move from tape-based recording media to the more flexible solid-state recording media, this industry has continued to grow exponentially. This growth has been aided by environmental concerns over producing and developing film, the ease of operating a video camera (compared to its film equivalent), and improvements in automated motion-tracking algorithms. All of these points have caused traditional high speed film users to reevaluate their requirements and take a closer look at the digital alternatives. For example, the once strong 16 mm film camera market has surrendered to high speed video cameras, and newer digital systems can easily outperform anything a 16 mm film camera could reliably and repeatedly achieve in high speed.

CMOS sensor development technology has improved and continues to do so, providing more sensitive megapixel cameras and ever-higher resolution cameras — both at reasonably fast framing rates. High speed digital imaging is making headway into the remaining few bastions of aging 35 mm and 70 mm film technology.

The ease of operating a high speed camera is now very close to the ease of operating a domes-

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tic camcorder. A greater number of individuals are comfortable operating computers today than ever before, resulting in greater numbers being able to operate what is, in reality, a pretty complex camera system. This is a significant change from the specialized photographic knowledge that was previously required to operate a high speed film camera. This ease of use, along with the benefit of having immediate results for playback and review, and the additional attraction of lower pricing for complex, high speed imaging systems sensitive enough to operate at thousands of frames per second in ambient light, has created many applications previously not viable for high speed photography.

Silicon Photodiodes

By Opto Diode Corporation

The silicon photodiode market for medium to high end applications has changed significantly over the past five years. Opto ASIC's (application-specific integrated circuits) are used almost exclusively in the optical encoder market, both for absolute and incremental encoders. CCD costs have dropped to the point where this technology is a replacement for photodiodes where fine pitch linear arrays are used. And in industrial photo control applications, where photodiodes are still used, the high volume, low-cost photodiodes from Asia have improved and are replacing higher end photodiodes from the United States and Europe.

In addition to these dramatic changes, there are several encouraging trends in the marketplace today. The demand for photodiode assemblies from the medical diagnostic industry (e.g. lab equipment manufacturers) continues to increase as dye chemistry improves and is applied to new areas. Scanning applications for both medical and homeland security are also increasing. Additionally, the military's need for photodiode devices for their laser-guided-missile programs continues to show growth.

These higher-demand markets for silicon photodiodes and assemblies are keeping United States photodetector suppliers inventive. The challenge is to both reduce costs and increase performance to maintain an edge over alternate technologies and overseas suppliers. A 6-inch (150 mm) diameter wafer capability is required to address the cost pressures of the volume scanning

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industries. Moving away from diffusion technologies and embracing ion implant processes are necessary to achieve the noise current properties of the most demanding customers in the medical diagnostic markets. Fine resolution needed by the military market dictates modern equipment and cleaner wafer fabrication facilities. Suppliers will need to work diligently to meet these demands.

As high-end OEMs continue to ask vendors to provide turnkey assemblies that include emitters and detectors, manufacturers must have the capacity for volume production and the technical expertise and ability to provide in-house testing. Having optical or photonic engineers on staff is becoming a critical requirement for testing emitters for all parameters, including peak wavelength, spectral bandwidth, chromaticity, and power output. This testing capability greatly enhances the value of the photodetector vendor to the end customer and will become even more important as the requirements of the industry become more demanding.

Optics

By Deposition Sciences, Inc. (DSI)

The 21st century has brought with it many changes in the optics industry. This new century has seen projection displays go from bulky, expensive boardroom tools to television sets in the living rooms of average households. Major advances in optics and optical coating technology have been driven by the demands of the telecom boom. These events have moved optics into the realm of the consumer. This move into the consumer market has required manufacturers to increase efficiencies and reduce costs, yet produce high quality products that meets today's market demands.

Another major change in the optics industry is the emergence of the light-emitting diode (LED). This new, revolutionary source of light is very bright, very compact, and very energy efficient. Based on semiconductor technology, it can be mass-produced by the millions in domestic or off-shore wafer fabrication facilities. This new light source has the potential to replace conventional lamps in many markets. Already, LEDs are being mainstreamed into automotive, medical, and aircraft lighting systems. With the continual rapid increases in energy efficiency, they will quickly find their way into general lighting applications.

Similar to the projection display and the telecom markets, the LED trade represents a great opportunity for the optics community to reinvent itself. The optics industry must face the challenges of optics that are small in size, high in performance, long in life, and low in cost. Meeting these demands in this market will require a blending of semiconductor and optics technologies. The optics for the LED industry will need to be made of plastic or metal to meet cost targets. Thin films will need to be developed to improve the heat dissipation within these devices. Other films and optics will need to operate at high angles of incidence to improve collection efficiencies of the LED output into the lighting systems. Developing partnerships between LED manufacturers, system integrators, and optics and thin film manufacturers will be the key to drive this new technology to success. ●

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