

Expertise in lighting and optics takes vision inspection to higher levels

Christian von Ah* shows how Emhart Glass is helping manufacturers meet strict quality requirements for glass containers through pioneering advances in vision inspection technology.

To maintain or grow their positions in the highly competitive container market, glassmakers require faster production speeds, lower costs, and higher quality. This has led to the development of faster, more efficient forming machines such as the Emhart Glass NIS; better control systems such as the Emhart Glass FlexIS; and inspection systems that innovatively apply advances in quality assurance technologies, such as the Emhart Glass Veritas.

Since the mid 20th century, Emhart Glass has been a leading innovator in inspection technology. It started with well-known mechanical inspection machines and, later, introduced some of the first high-speed vision systems for base and sealing surface inspection in the 1980s. Today, with the introduction of the Veritas iB and Veritas iC, Emhart Glass is taking vision inspection to even higher levels.

All vision systems include three basic components: cameras, optics/lighting, and image processing systems. The real strength of any vision inspection system is the perfect combination of the best possible image with highly sophisticated algorithms for the inspection being performed. This is the job of the cameras and, more importantly, the optics (lenses) and lighting. The right combination of optics and lighting allows the camera to capture the right type of image for analysis by the

inspection algorithms (software).

Innovations in optics and lighting design from Emhart Glass, combined with continuing improvements in camera resolution and ever more powerful algorithms, are setting new standards for flexibility and accuracy that will enable glass container manufacturers to meet higher quality standards in the challenging container market.

Several algorithms have been developed – and more are under development – to find all possible defects in any location of the container. Some examples:

- ◆ In the base inspection, it is possible to find stones or small pieces of broken or stuck glass, in the stippled area of the base when filtering out the regular pattern and looking only for irregularities (**Fig 3**).
- ◆ For base inspection on non-round containers, other algorithms allow images to be rotated or aligned to allow for consistent overlaying of inspection zones on difficult to inspect containers.
- ◆ Another group of algorithms enables sidewall inspection of

embossed areas on the container that other vision systems often cannot inspect at all.

Capturing high-quality images requires more than just good cameras. It requires high-quality light from the right direction, with the proper brightness and timing. Various arrangements of lights, mirrors, polarisers, and beam splitters help get the right light in the right place. Emhart Glass pioneered the use of LEDs for lighting. Unlike other types of filament or vapour-based lighting, LEDs maintain their light intensity over a long lifespan. Brightness and colour are more controllable and, in turn, more predictable leading to consistent image quality.

The Veritas iC has more than 18,000 LEDs on six independently programmable light boards used in a patented wrap-around lighting design that enables uniform 360° lighting of containers as they pass through the system's two inspection stations at speeds of up to 600 bpm. Using six cameras with double image acquisition, this design allows the system to capture 12 images performing the accurate non-contact sidewall, sidewall stress, and dimensional inspection.

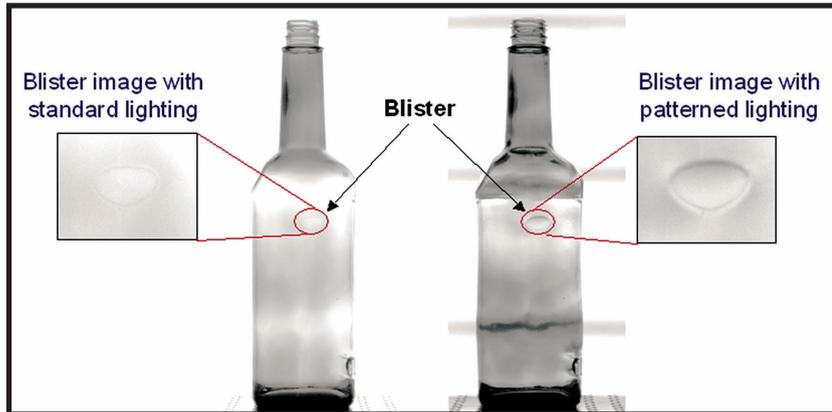
The effectiveness of the patented design of using patterned lighting can be seen in **Fig 1**. In this image, the same light sources are switched from standard to patterned lighting in microseconds. Standard lighting is effective in highlighting opaque defects, such as stones and seeds, but tends to wash out the edges of large blisters, especially those with relatively soft edges. When the light is switched to an adjustable patterned arrangement where alternate rows of LEDs are turned off, blisters become easy to see. The easier the defect is to see in the camera image, the easier it is for the inspection software to detect and analyse.

A similar type of near-instantaneous switching is used for image acquisition for stress inspection. The Veritas iC is able to use the same cameras to inspect for both sidewall and sidewall stress inspection through a patented technology that switches from standard lighting to polarised lighting in microseconds. The same array of cameras is able to capture two images for two inspections that have different image requirements.

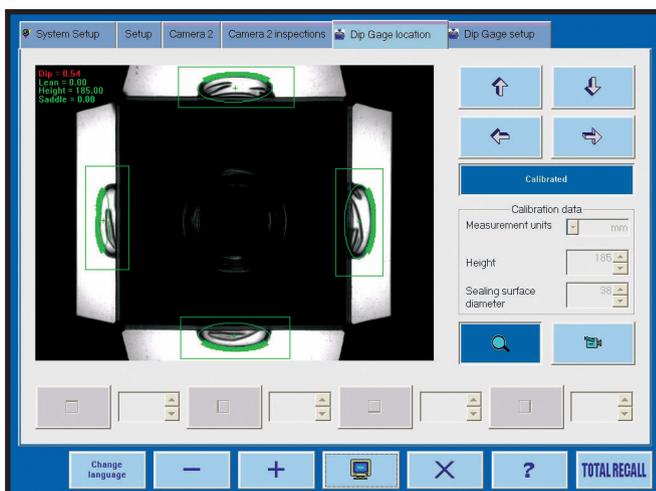
These innovations are all standard equipment on the Veritas iC, and allow high-speed, high-quality inspection of round and non-round containers, including embossed areas.

In the Veritas iB, other patented lighting/optics designs are setting new standards for base and sealing surface inspection. The Veritas iB incorporates the proven vision inspections found in the earlier Emhart Glass ProScanner series and takes it to a new level of user friendliness.

The Veritas iB includes both new



▲ **Fig 1. Bottle image on right shows use of patterned lighting to make it easier to see blister defect.**



▶ **Fig 2. Vision dip inspection image from Veritas iB showing detection of dip defect.**

innovations in lighting and inspection, as well as container handling. All adjustments – from the patented belt handler, to the setting of lenses and camera heights – are motorised and programmable. Switching from the current job to a stored job takes less than four minutes.

In addition to base, base stress, sealing surface inspections, and vision mould number reading (top down) which are standard equipment, the Veritas is also available with the patented vision dip and vision plug inspections, all at up to 600 bpm. Unlike mechanical go/no-go gauges, these vision devices base their inspections on actual measurements. This improves the accuracy of the inspection and can reduce good ware rejects.

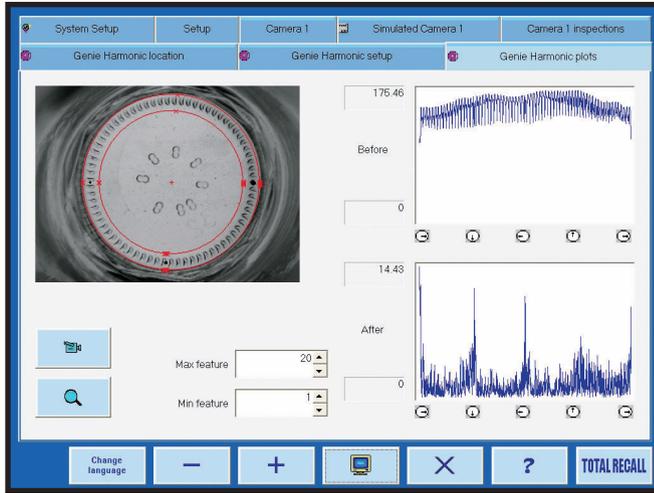
Unlike other vision inspection systems that attempt to perform dip inspection from an overhead view of the container, the Veritas iB uses an arrangement of LED light sources and

mirrors that allows a single camera to look across the top, or horizon, of the finish. This provides the camera with four overlapping 120° views. In these images, as shown in **Fig 2**, the depth of a void or defect is easy for the system to see and analyse.

For sealing surface inspection, the Veritas iB continues the use of a patented light field illumination design first introduced in the ProScanner series. Many sealing surface inspection systems use a single, directional light source for dark field illumination of the sealing surface. This type of lighting is

excellent at highlighting edges and is generally capable of seeing only the very top of the finish. Light field illumination combines the use of directional and non-directional light to provide a more detailed view of the entire finish with more depth of field. This often allows the camera to see further down into the sealing surface making it possible to see some defects, such as small blisters, just under the sealing surface. Additionally, this type of lighting significantly improves the detection of lineover defects.

The Veritas iB also includes improvements in wide mouth



◀ Fig 3. Base inspection algorithm in Veritas iB shows how defect is detected when hidden among stippling. Top window shows the unfiltered signal. The bottom image shows how filtering software detects the defect in an otherwise noisy signal image.

container inspection, an area that Emhart Glass pioneered in the 1990s. It is capable of plug and sealing surface inspection of finishes up to 130mm in diameter and up to 120mm in diameter for vision dip inspection. For vision plug inspection a depth of up to 140mm is possible.

Working closely with vision inspection technology partners, Emhart Glass has combined its expertise in machine, lighting, and optics design, with powerful algorithms that are able to provide unparalleled image analysis. Production flexibility and innovation have revolutionised container forming and are allowing glassmakers to compete against other packaging materials by providing cost-competitive products that meet their customers' requirements.

The same has occurred in container inspection, where innovations in vision technology go hand-in-hand with innovations in forming and control technologies to ensure that products shipped to customers meet increasingly more stringent quality requirements.



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