Application Notes & Technical Tips

# When To, and When Not To Use Polarizing Filters in Vision

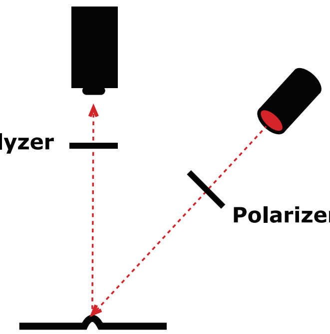

Fig. 1

One universal obstacle to quality vision lighting on the plant floor has been unwanted glare, typically from the sample itself, but also from factory ceiling lighting or other dedicated task lighting. We are going to concentrate on reducing glare from the vision lighting, particularly from a sample's curved, specular surface, which is the most common application use for polarizers.

Historically, the solution to this problem, particularly before the advent of structured and multiple geometry lighting, was to employ a set of polarizing filters, one known as the polarizer, attached to the light, and one known as the analyzer, attached to the camera lens (Fig. 1). Following tradition, the analyzer would then be rotated relative to the polarizer, in the hope light produced from glare could be stopped from passing into the camera lens.

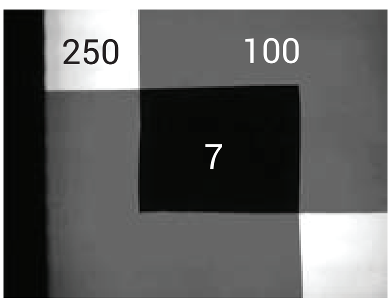

Fig. 2a
Numbers Represent Intensity (0-255)

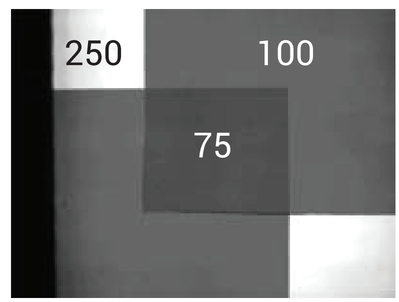

Fig. 2b
Numbers Represent Intensity (0-255)

This solution can be effective; however, there are limitations. Remembering that when rotating 1 of 2 stacked polarizers, the light transmission varies between maxima and minima every 90 degrees of rotation (360 degrees being 1 rotation). In the case of transmission minima, we are near full extinction, and very little, if any light is passed (< 3% Fig. 2a – center area) – making it often unsuitable for vision inspection. And even at transmission maxima we see at best partial transmission (30% Fig. 2b – center area), thus making this technique less useful, sometimes even when the glare is blocked at transmission maxima, depending on the intensity of light available. It is noteworthy that even with a single polarizer, light transmission is decreased to 40% of the total.


Fig. 3a
RL4260-660

In this instance there is a better solution: Modify the lighting geometry – that 3-D spatial relationship among the sample – light – camera. In this example, we have investigated the use of standard polarizers vs. a change in lighting geometry in obtaining an acceptable image for inspection. The sample is a bottle of styling gel; it is clear plastic, reflective and curved, which we might expect to generate a large amount of reflective glare, depending on the lighting type and geometry used.

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Fig. 3b
Coaxial Ring Light
No Polarizer

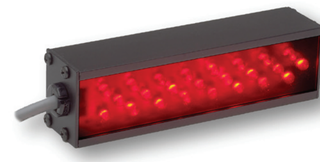
Fig. 4a
Off-Axis Ring Light
No Polarizer

We viewed the bottle in a standard geometry, typical of many vision systems with the camera oriented perpendicular to the label surface, using a standard co-axial ring light (See Fig. 3a) attached to the camera and lens without polarizers (Fig. 3b). As might be expected, the coaxial geometry exhibits considerable glare directly from the coaxial ring light. Fig. 3c shows the image with crossed polarizers, and whereas the image may or may not be acceptable, depending on the inspections required, we still see some remnants of the light glare in the center of the image. It should also be noted that we had to open up the lens by 2 f-stops to get approximately the same illumination level into the camera.

Fig. 3c
Coaxial Ring Light w/
Crossed Polarizer

If we now change lighting geometry by moving the ring light off-axis with respect to the camera and lens, but in the direction parallel to the bottle's long axis, we generate the image depicted in Fig. 3d, which is free from any remnants of glare. The off-axis ring light is an acceptable solution so long as the light can be fairly close overhead, but it must be oriented pointing parallel to the bottle long axis in this instance. If we could not orient the light in this fashion because of access limitations, are there other geometry/ structure solutions available?

Fig. 4b
BALA Oriented
Longitudinally

Fig. 3d
Off-Axis Ring Light
No Polarizer

We investigated using a broad linear array light (BALA), AL4424-660 (See Fig. 4a) in both the longitudinal (Fig. 4b) and transverse (Fig. 4c) orientations, and determined that the transverse BALA orientation works as well as the off-axis ring light. What advantage does the

Fig. 4c
BALA Oriented
Transversely

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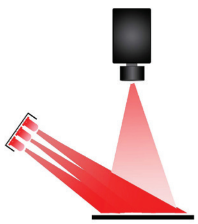

Fig. 4d
BALA Light Function Diagram

BALA orientation confer? It can be mounted from further away and at a lower angle from horizontal, thus allowing the near overhead area to remain open, unlike the ring light. Fig. 4d shows the BALA light function diagram.

Are there additional appropriate uses for polarizers in vision? The 2 most common uses are both in back lighting applications. A special form of polarizing film can be used as a light collimator, if placed over a back light. The polarizer passes the parallel rays only from the previously diffused and randomized light, which allows for better edge detection when attempting high-precision gauging from a back lit image. The other use is to detect physical anisotropies in transparent and translucent materials, such as plastics. Figs. 5a and 5b are back lit images from polypropylene film, with and without polarizers, illustrating the strain field in what otherwise looks like normal plastic.

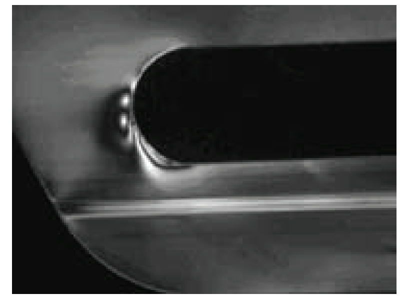

Fig. 5a
Back Lit Plastic Film w/ Crossed Polarizers

Fig. 5b
Back Lit Plastic Film; No Polarizers