Effective Lighting Geometries for Plastic Lid Inspection

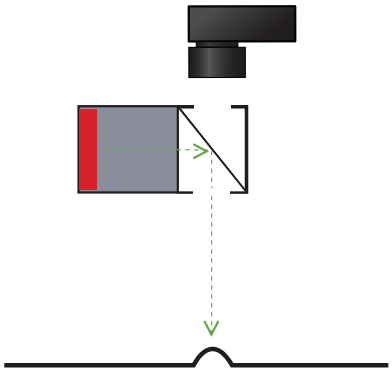

Fig. 1a
Coaxial Ring Light
Diagram

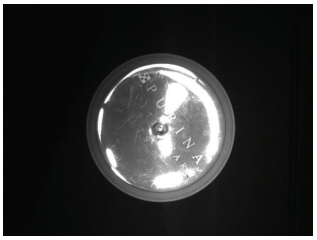

Fig. 1b
Coaxial Light
Geometry Image

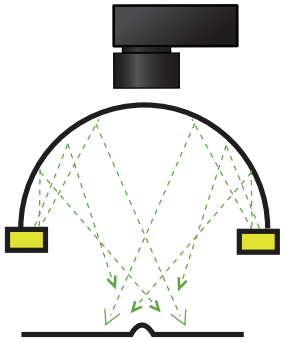

Fig. 2a
Diffuse Dome
Diagram

Lighting plastic lids for surface print and/or screening inspections is challenging. Variations in surface texture, reflectivity, color, orientation, as well as different sizes and quantities, running at different speeds and feeds - all affect the choice of lighting geometry best applied. In an ideal case, we can inspect a singulated, small, non-reflective lid for printing or screening defects under a standard vision lighting geometry – namely a coaxial ring light oriented around the lens, and pointed perpendicular to the lid surface from a medium working distance, typically less than 20 inches (Fig. 1a). However, few, if any plastic lids are non-specular, thus a coaxial light geometry typically produces unsatisfactory results for inspection purposes (Fig. 1b).

Flat specular surfaces with topography may respond to diffuse lighting techniques sufficiently well enough to accomplish the inspection goals. However, there are two important criteria for proper application of a diffuse flat, dome or cylinder light: 1) the light must be close to and directly over the part, and 2) the camera must also be close to the light to view without "port-holing", further requiring the lens focal length to be considered (Fig. 2a). This close proximity may limit the ability of robotic arms, or operator-in-the-loop operations as well. In this example, the diffuse dome light works well for differentiating the edge from the center flat areas, but does not produce an evenly reflective surface for print inspection (Fig. 2b).

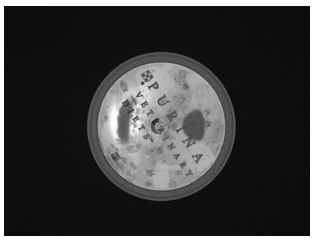

Fig. 2b
Diffuse Dome
Geometry Image

Thus far we have discovered that neither lighting technique – partial or full bright field - are particularly effective on this common plastic lid sample, primarily because of non-uniform reflection from a high angle. Are there other choices?

Of the available techniques, we might test dark field and also medium angle, off-axis bright field. Remembering the low angle geometry from the dark field light function diagram, we see that whereas the majority of the incident light reflecting from the sample's specular flat surface will not reach the camera, we

Released 4/20/2016

Effective Lighting Geometries for Plastic Lid Inspection

Fig. 3a
LL174 Series

cannot view the surface for print inspection because the surface is dark. This leaves us with the choice of medium angle bright field lighting to negate the specular reflection, while still allowing for the surface print inspection.

Fig. 3b
Opposed LL5806 of Lid

If we examine an image taken using two opposed high-current linear lights, such as from the LL174 Series (Fig. 3a), we see that this lighting geometry is effective for properly illuminating the surface of the lid for print verification (Fig. 3b). In effect, we have borrowed from a dark field technique to channel the higher angle specular reflections away from the camera, while still allowing for the lower angle reflections to be collected, thereby lighting the surface effectively. As an added benefit of this geometry, we also have better part access because of the relatively remote location of the high-current lights.

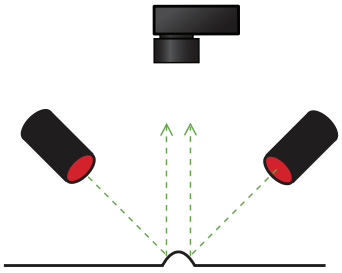

Fig. 3c
Off-Axis Bright Field Diagram

Fig. 4a
LL174 Series
Opposed LL6212
of Lid

One final benefit of this opposed off-axis geometry is the flexibility it affords for inspecting a larger size or number of lids using longer standard linears seen in (Fig. 3a) used in the image depicted in Fig. 4a. For even larger fields-of-view, we can offer the expandable series, LL174 (Fig. 3a) as well. The high-current LEDs used in these lights are also well-suited to strobing in high speed applications for even more intensity.