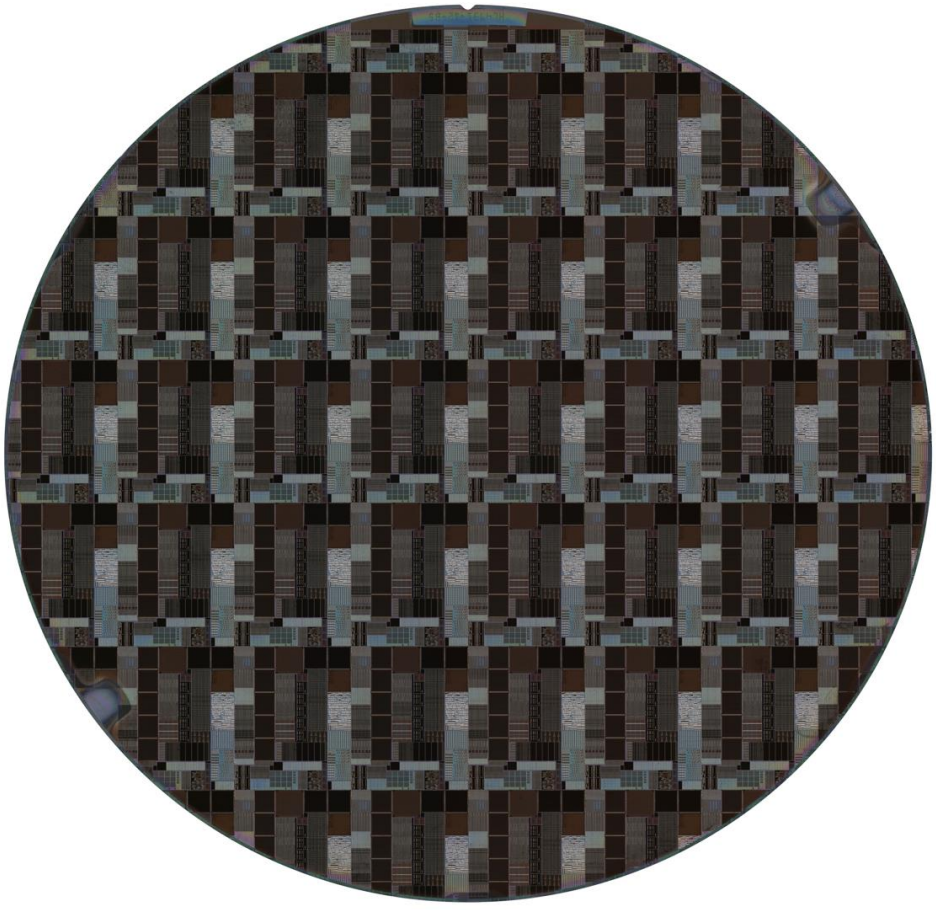
chromasens
IMAGING FOR PROFESSIONALS

# Intensity optimized (x20) bright field and coaxial line light source for challenging applications

*Application report*



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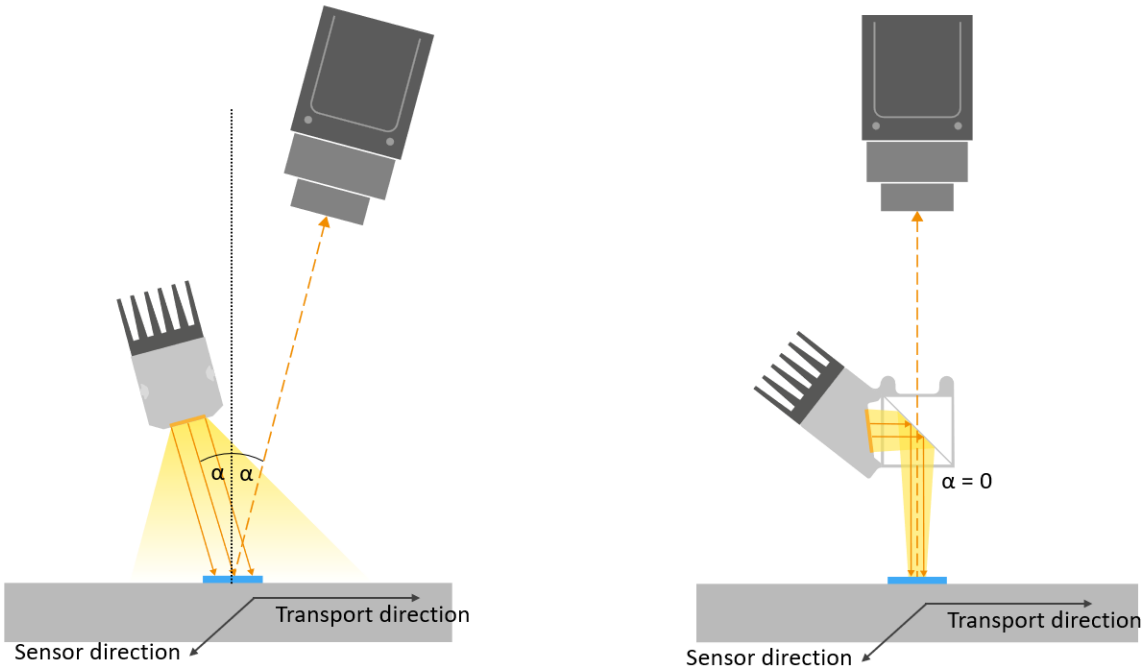
V1.0

## Content

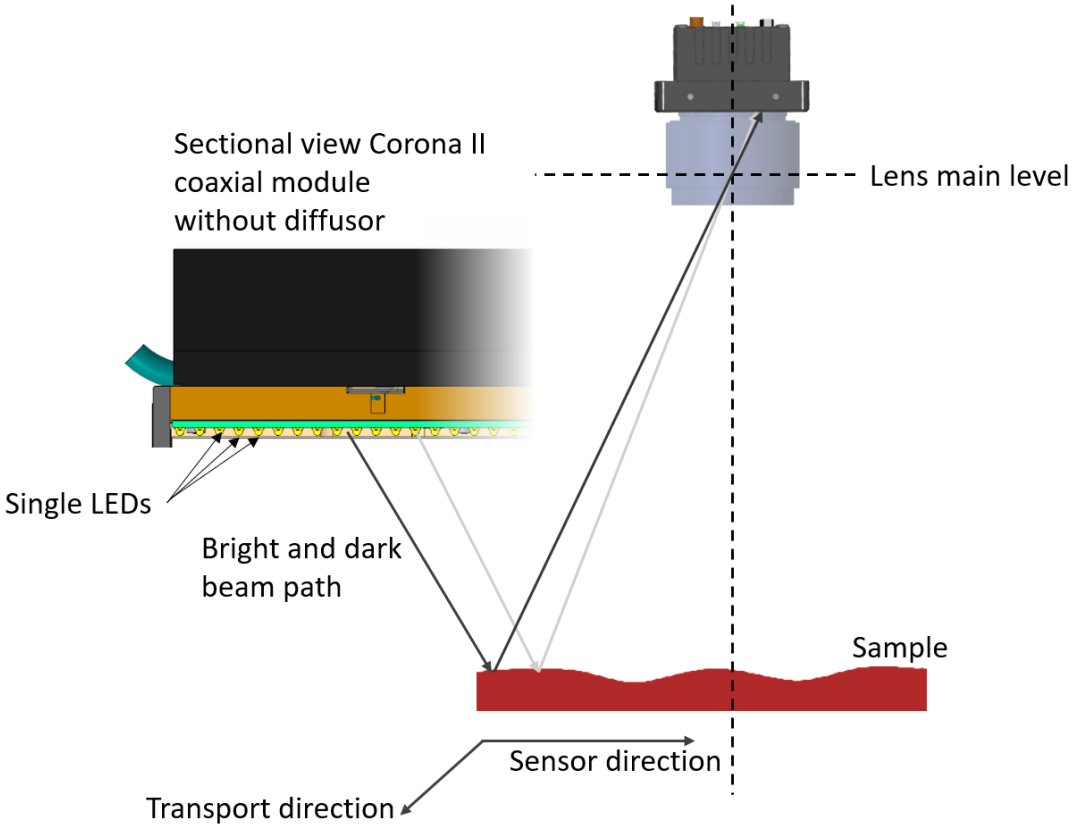
## 1. Brightfield illumination principle

For highly reflective or mirroring surfaces a brightfield or coaxial illumination is often used to inspect surfaces. Flat surfaces appear bright in this illumination geometry. The physical working mechanism is the law of reflection. The angle of reflection equals the angle of incidence. The camera looks through the surface directly into to light source. The coaxial illumination is a special case of this general principle, the angle equals zero.




## 2. Standard light design approach

Since the camera looks through the mirror directly into the light source, the camera images the combination of surface properties and illumination properties. Since it is not the aim to image the illumination, the appearance of the illumination must be homogenous. In professional illumination systems the light source is in the most cases a LED array. These LED arrays are multiple single LEDs soldered on a PCB on a row or in a matrix. For Corona line lights PCBs with 30 LEDs in a row are used. Since there is space between the LEDs, the radiation in row direction is not homogenous. In the sketch a section view of a corona module without diffusor is illustrated. The single LEDs are visible in yellow. The space between the LEDs is imaged on the sensor, alternating with a single LED itself. The dark and the bright grey arrow illustrate this as an example for 2 locations.




This leads to an inhomogeneous appearance of a homogenous surface like the unprocessed wafer in the following image pair. Since the LED are not in the object plane of the lens, the transition between bright and dark is blurry but still unacceptable.

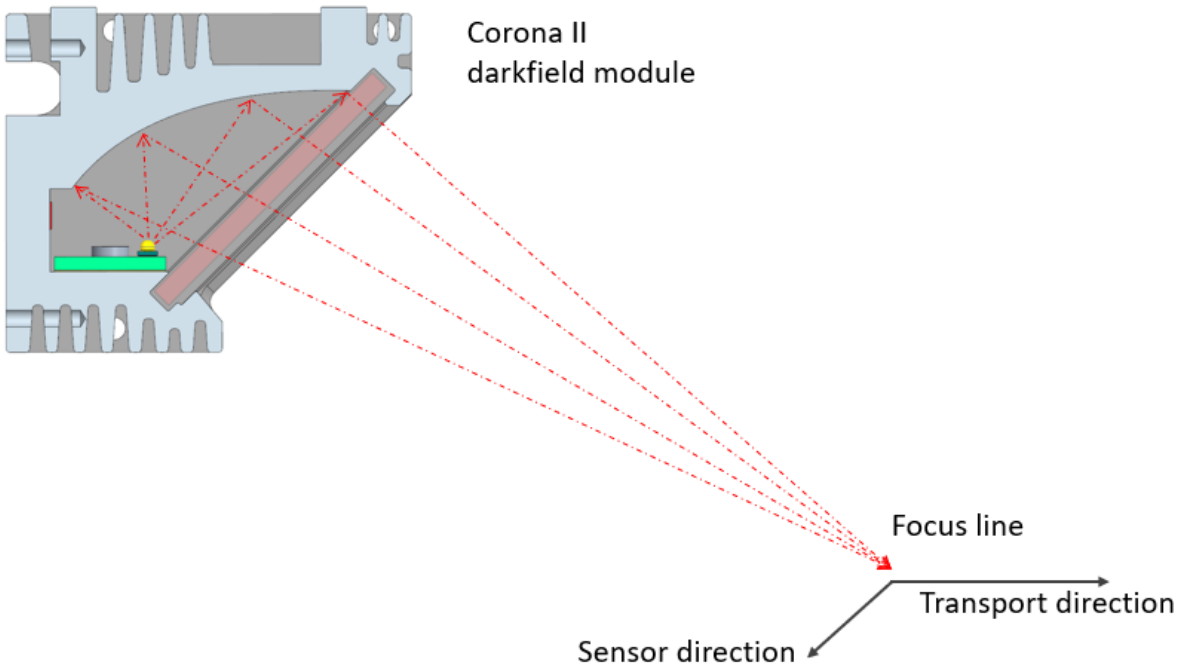
Unprocessed wafer without diffusor in coax-brightfield

Unprocessed wafer with diffusor in coax-brightfield

The standard approach is to apply a strong diffusor on the light source. Since the light is diffused in all directions, the image appears very homogeneous. Disadvantageous on this approach is, that a large amount of light is not reflected into the camera lens and therefore does not expose the image sensor. This leads to a low efficiency of the illumination, high camera gain values or large exposure times are necessary.

## 3. Chromasens anisotropic diffusor approach

In comparison to Corona brightfield modules, Corona darkfield modules focus the emitted light on defined (scan-) line profile with a 2D parabolic mirror. This results in a much higher illuminance. There are different focal length options available.




However, also here the single LEDs are visible in the image since the camera looks through the mirroring surface of the object and the parabolic mirror directly in the inhomogeneous light profile of the illumination. A diffusor would solve this issue but destroy the focus property of the illumination.

To avoid an inhomogeneity due to the single LEDs, the Chromasens illumination portfolio has a special screen option available for darkfield modules. With this screen option these darkfield modules can be also used as a high power brightfield light source.

| ProductID | ID1 | ID2 | ID3 | ID4 | ID5 | ID6 | ID7 |
|---|---|---|---|---|---|---|---|
| CP000200 | 340 | C | 04 | 2.5 | B | 1 | B |
| General identifier for Corona II products | Optical Length of Module | Reflector Type | LED Color | Cable Length | Connector | Screen options | Heat sink options |

| ID 6 | Screen options | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Glass (with little diffusion) GW 55 (standard) | 170 | 340 | 510 | 680 | 850 | 1020 | 1190 | 1360 |
| 2 | Glass (with polarization) GW 55 | 170 | 340 | 510 | 680 | 850 | 1020 | 1190 | 1360 |
| 3 | Plexiglas (low diffusion) GW 55 | 170 | 340 | 510 | 680 | 850 | 1020 | 1190 | 1360 |
| 4 | Plexiglas (medium diffusion) GW 4 | 170 | 340 | 510 | 680 | 850 | 1020 | 1190 | 1360 |
| 7 | Glass (medium diffusion) GW 4 | 170 | 340 | 510 | 680 | 850 | 1020 | 1190 | 1360 |
| B | Glass (GW 55) and anisotropic diffusor | 170 | 340 | 510 | 680 | 850 | 1020 | 1190 | 1360 |
| 0 | Bright field screen (only for option 2:“H“) | 170 | 340 | 510 | 680 | 850 | 1020 | 1190 | 1360 |

The anisotropic screen is a direction dependent diffusor. The light is diffused in scanline direction but not in the perpendicular (transport-) direction. This leads to a very high illuminance with a perfect homogeneity. The following image shows the refraction of a laser beam which symbolizes a focused single LED. In the left part of the image the laser is focused on a point. In the right part of the image the laser is refracted by the anisotropic diffusor in one direction and therefore is imaged as a line. This line is in the case of a Corona illumination the scanline area. The superposition of all single refracted LEDs leads to an illuminated line profile that is focused in transport direction but is perfectly homogenous in sensor direction.

For a test series with different wafer surfaces the amount of light on the sensor was **20 times higher** for the darkfield coax module with anisotropic filter than the brightfield coax module. In terms of illumination homogeneity both solutions are equal.

The name of the illumination “darkfield module” is misleading in this case and is caused by the typical application of focused illuminations.

## 4. Summary

For high resolution systems the pixel size must be small to ensure an adequate sensor length. At the same time, the requirement in terms of acquisition speed is continuously increasing. This leads to a strongly growing demand of illuminance. Especially with a coaxial module which devastate 75% of the light due to the construction with a beam splitter mirror it is very demanding to provide a sufficient amount of light.
The Chromasens focused bright field approach with anisotropic diffusor, which increases the illuminance by factor 20, is the key technology to solve such applications.

Chromasens illuminations:
https://chromasens.de/en/product/corona

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