

World's Largest Inventory of Optical Components

Illumination for Machine Vision

Jeremy Govier
Edmund Optics
Nov 23 2006

Importance of Illumination

Contrast at the image plane starts with contrast on the object

Illumination allows you to distinguish the object you need information about from the rest of the field

Sources

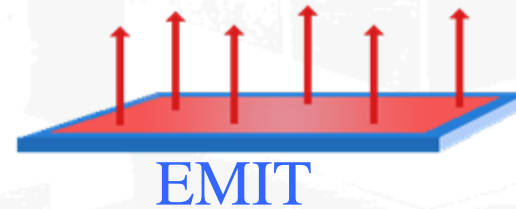
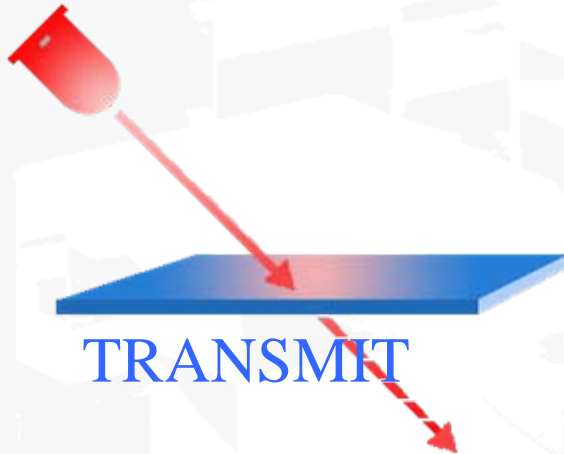
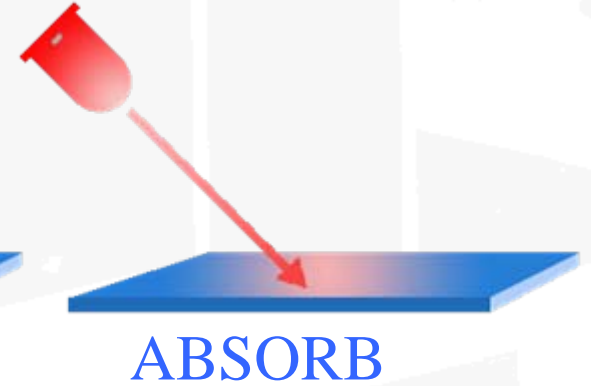
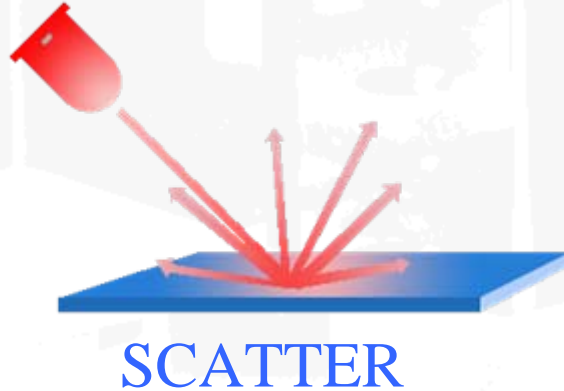
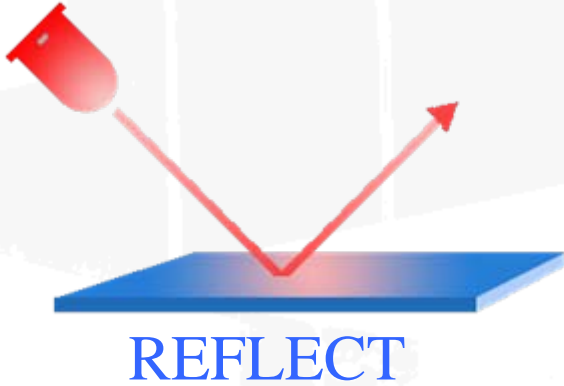
- LED
- Fluorescence
- Quartz Halogen
- Xenon
- Electroluminescent Panels
- Lasers

What Makes them Different?

- Wavelength
- Intensity
- Structure
- Longevity
- Heat
- Ease of Use

Type	Spectrum	Intensity	Life (hrs)	Comments
LED	Various	Medium to Bright	Up to 100,000	Long life Stable output
Fluorescent	White w/Blue-Green	Bright	5000 to 7000	Inexpensive Need High Freq
Halogen	White w/yellow	Very Bright	200 to 3000	Inexpensive High Heat
Xenon	White w/blue	Very Bright	3000 to 7000	Inexpensive Stable
Electro Luminescent	Green	Dim	2000 to 5000	Very Thin Low Heat
Lasers	Various	Extremely intense	Up to 100,000	Structured, non uniform

How Does Light Interact with the Object



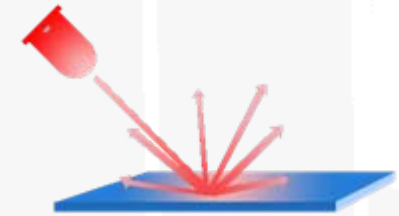
Light Interaction with the Object

How Light interacts with the object can be used to enhance contrast

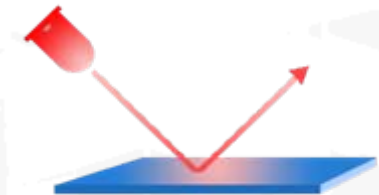
- Surface Finish
- Color
- Transparency
- Topography

Surface Finish

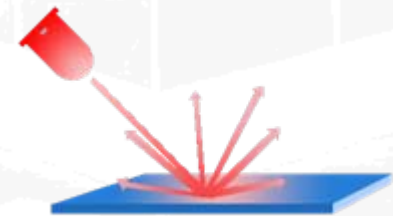
Diffuse Surfaces
paper, fabric



Specular Surfaces
metal, ink



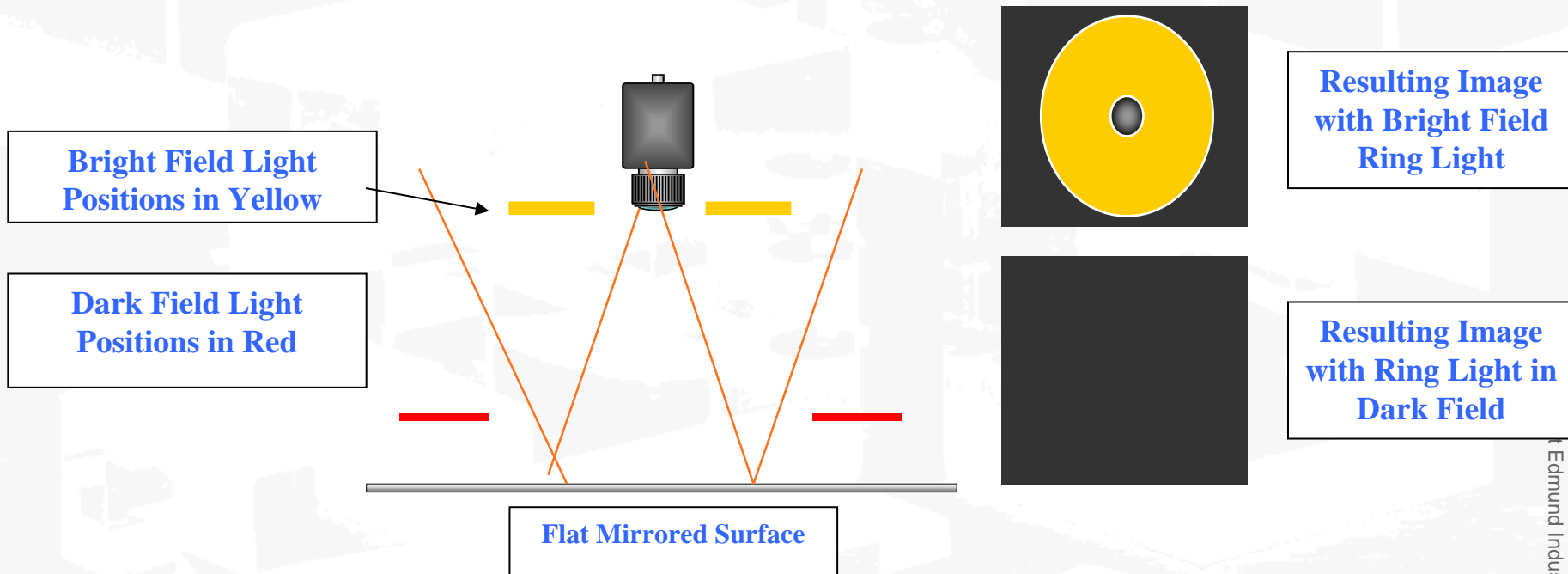
Mixed
plastics, most
surfaces



How Textures Can Be Used To Increase Contrast on Objects

Make Specular surfaces reflect brightly and diffuse dimly or vice versa using bright field or dark field illumination.

Understanding Bright Field and Dark Field Lighting Geometry



Using Transparency

Backlighting to separate the opaque from the transparent

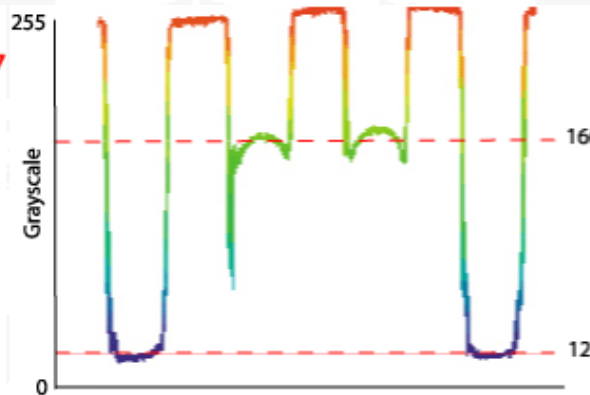
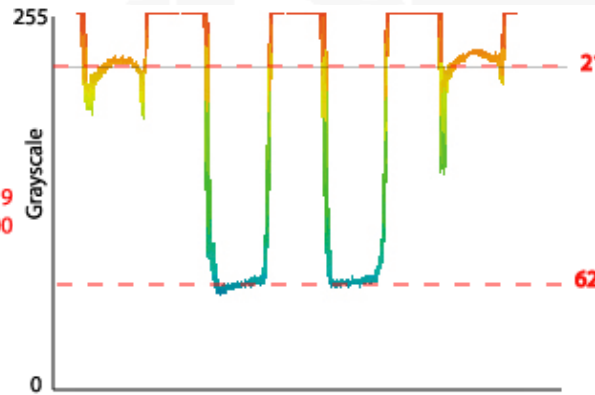
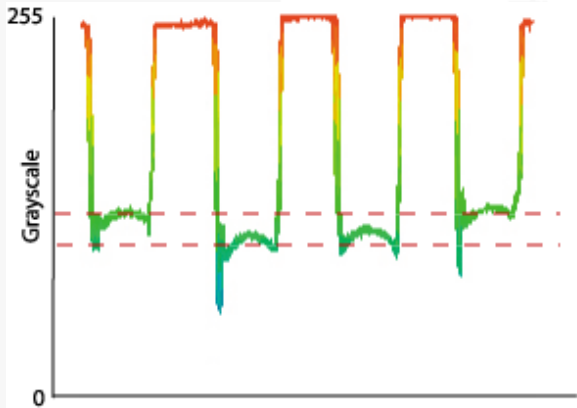
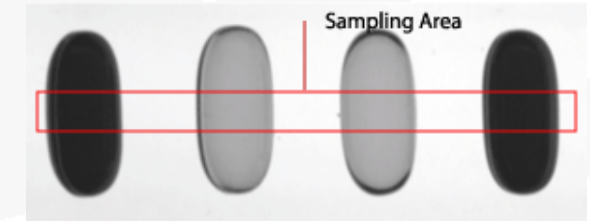
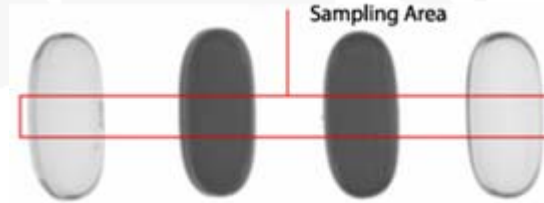
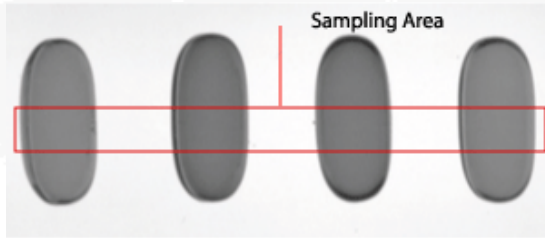
Separates edge information from surface information

Using Color

Filtering and lighting

Using Black and White imaging to get color information

Color separation

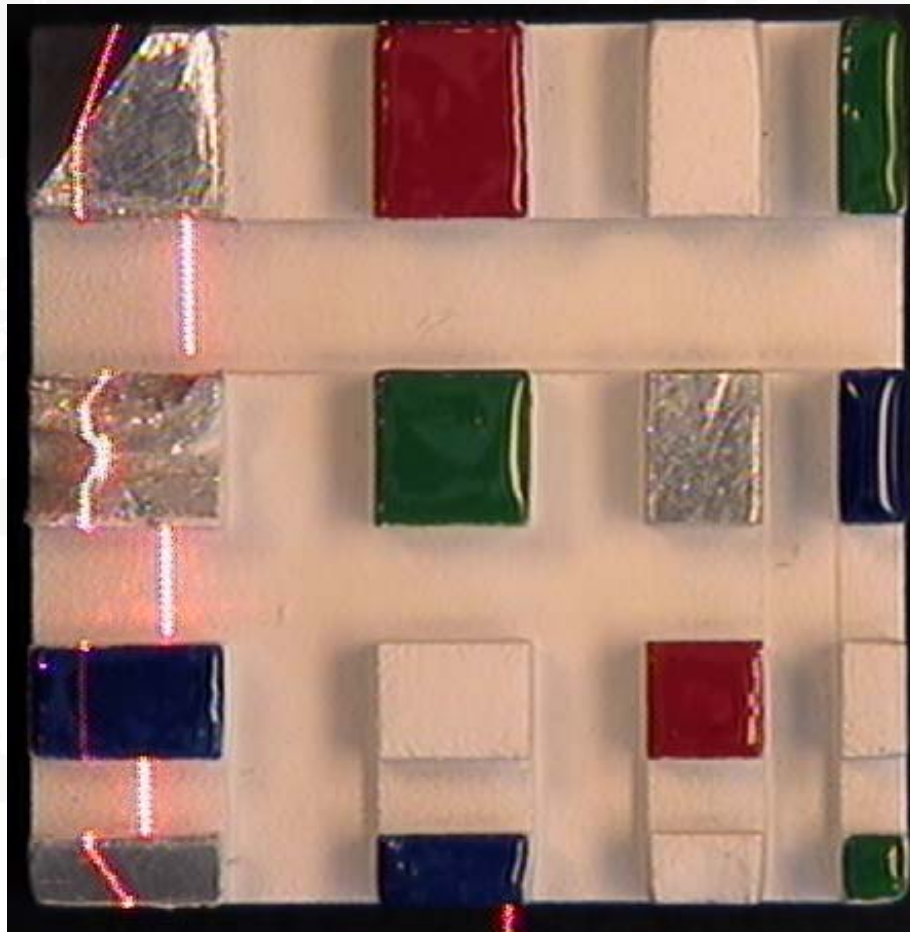


Topography

Directional illumination can enhance shadowing to reveal Z information

Structured illumination can also be used to measure z information in on an object

Topography



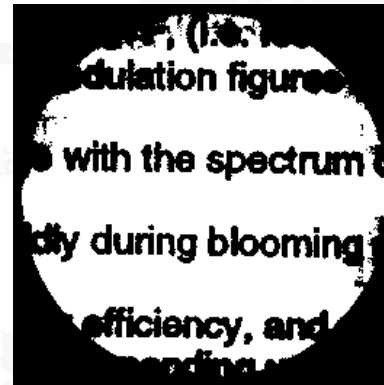
Uniformity of Illumination

Uniformity of illumination across the entire field is important to get contrast across the field

para MTF, (i.e. less than
modulation figures for
je with the spectrum of
idly during blooming s
fer efficiency, and cro
TF depending upon lo

para MTF, (i.e. less than
modulation figures for
je with the spectrum of
idly during blooming s
fer efficiency, and cro
TF depending upon lo

para MTF, (i.e. less than
modulation figures for
je with the spectrum of
idly during blooming s
fer efficiency, and cro
TF depending upon lo



S5

S6

Types of Illumination

Directional

Ringlight(Partial Brightfield)

Axial illumination(Complete Brightfield)

Dome

Darkfield

Backlight

Structured

Directional

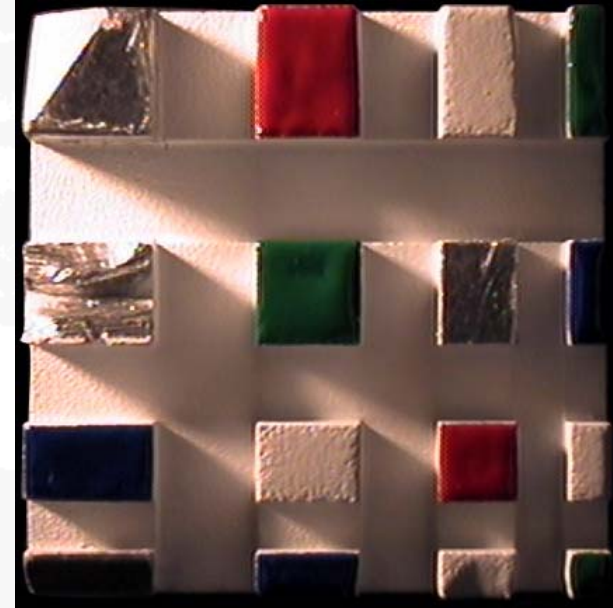
- Flexible Light Guides
- Semi-Rigid Light
- Spotlights

Benefits-

- Brings out surface topology
- High intensity
- Relatively even illumination

Drawbacks-

- Shadows
- Glare



Ring Light

Benefits-

- 360° Illumination
- Relatively even illumination
- Low shadows
- High Intensity

Drawbacks-

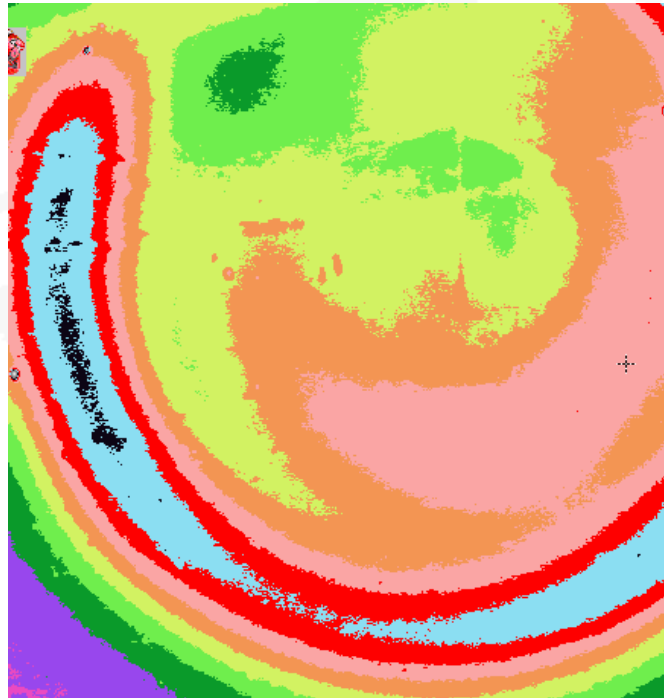
- Circular glare on highly reflective surfaces
- Can be difficult to mount



Partial Brightfield

Ring Light on Mirror

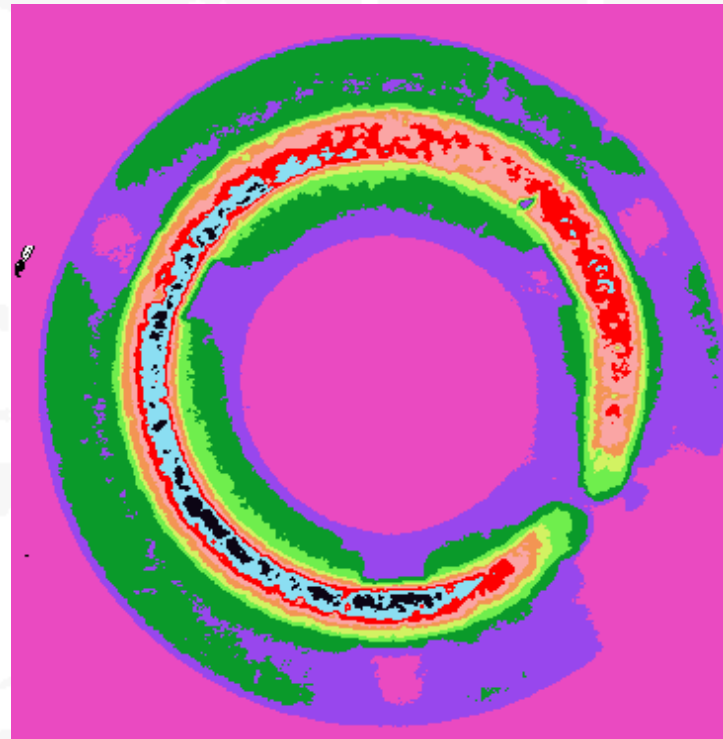
- Poor uniformity
- Large Standard Deviation



Partial Brightfield

Ring Light on Ball Bearing

□ Poor Uniformity



Axial Illumination

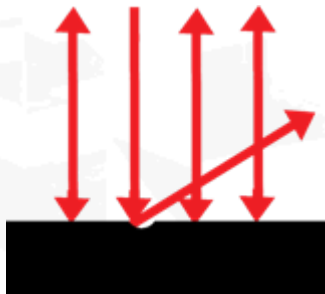
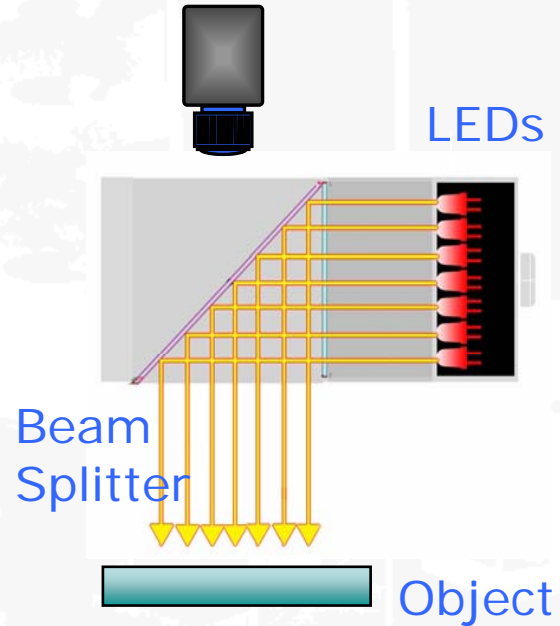
“Collimated” illumination folded into optical path in front of lens

Benefits

- Highly uniform
- Reduced shadowing
- Surface texture is emphasized

Drawbacks

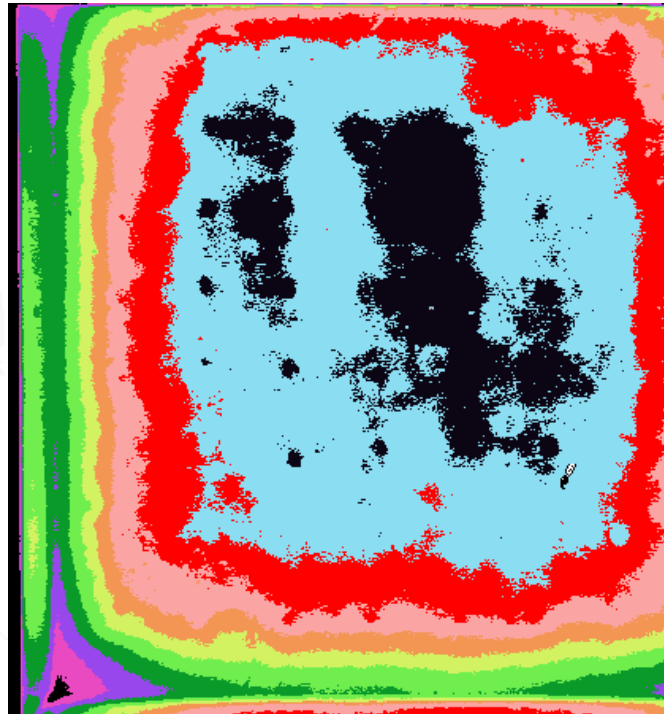
- Low intensity
- Bulky
- Stray light



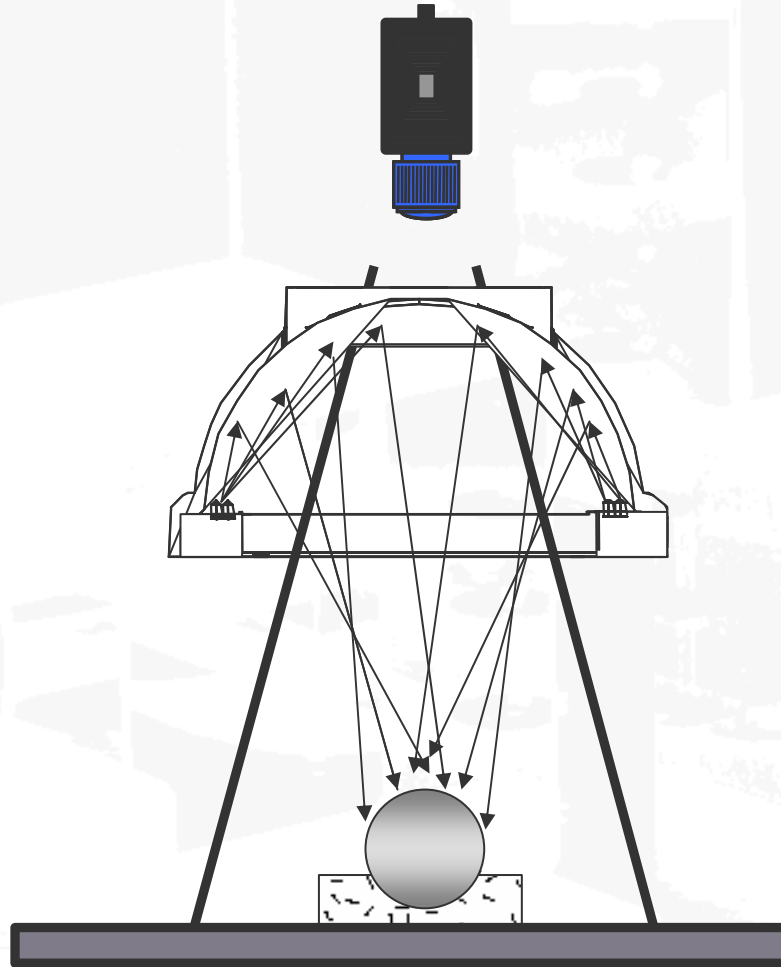
Complete Brightfield

Axial Diffuse Illuminator on Mirror

- Better uniformity
- Lower Standard Deviation



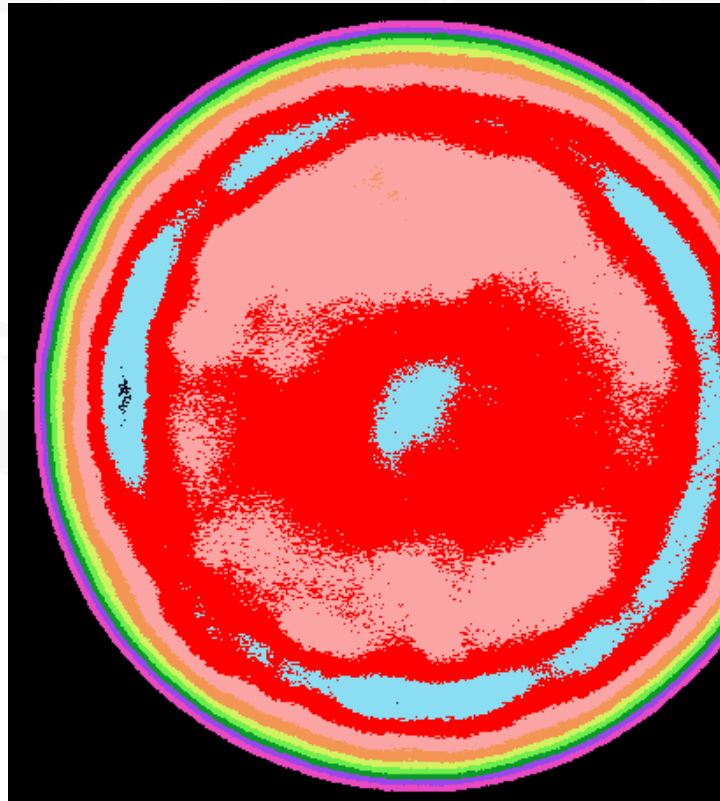
Dome Illumination



Large Solid Angle Brightfield

Dome Light on Ball Bearing

□ **Excellent Uniformity**



Concave Soda Can

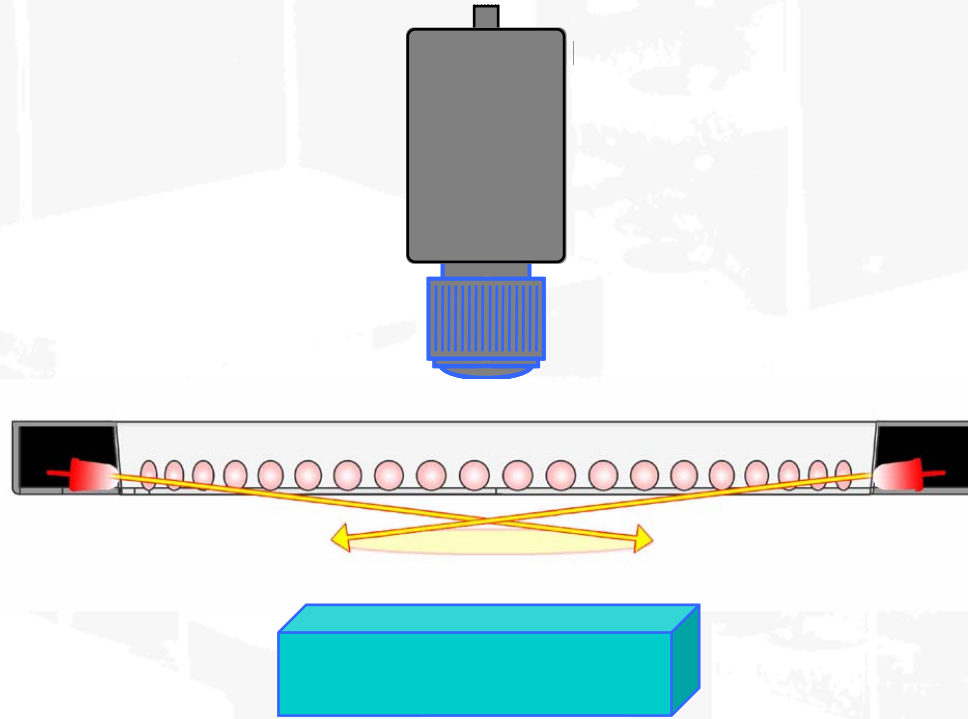
Ambient Light



Diffuse Light Source



Darkfield



Darkfield

Glancing incidence illumination

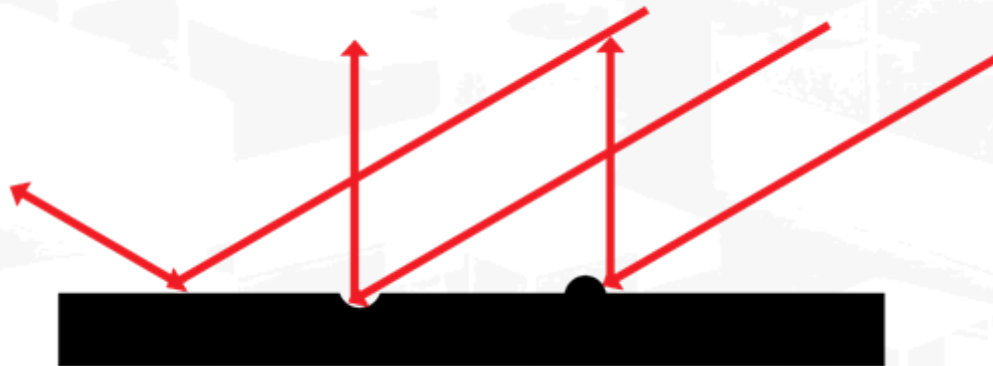
Benefits

Emphasized high spots and surface defects

Brightens diffuse surfaces, while darkening specular surfaces

Drawbacks

shadowing can occur



Bar Code under clear wrapping



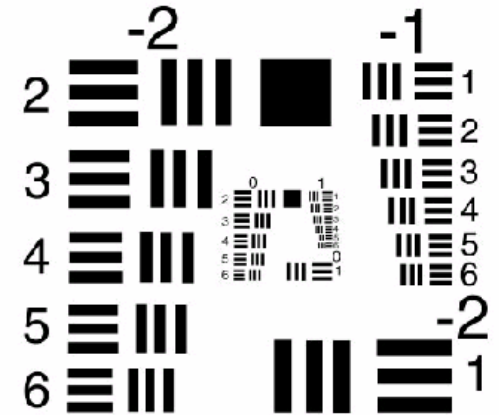
Backlights

Benefits-

- High contrast silhouetted images
- Highly diffuse
- Even lighting
- Good for edge detection

Drawbacks

- Difficult to see surface features



Structured Illumination

Benefits-

- Surface feature extraction
- Good with linear arrays

Drawbacks

- Extremely intense source
- Absorbed by certain colors

