2009 spring

Microstructural Characterization of Materials

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Contents for previous class

Image Quality

When you look at a specimen using a microscope, the quality of the image you see is assessed by the following:

- **Brightness** - How light or dark is the image?
- **Focus** - Is the image blurry or well-defined?
- **Resolution** - How close can two points in the image be before they are no longer seen as two separate points?
- **Contrast** - What is the difference in lighting between adjacent areas of the specimen?

Brightness

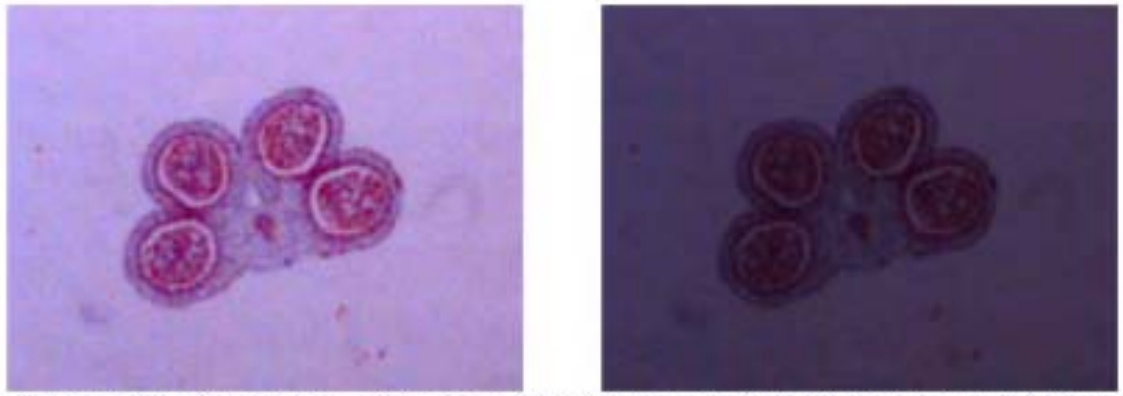


Image of pollen grain under good brightness (left) and poor brightness (right)

Focus

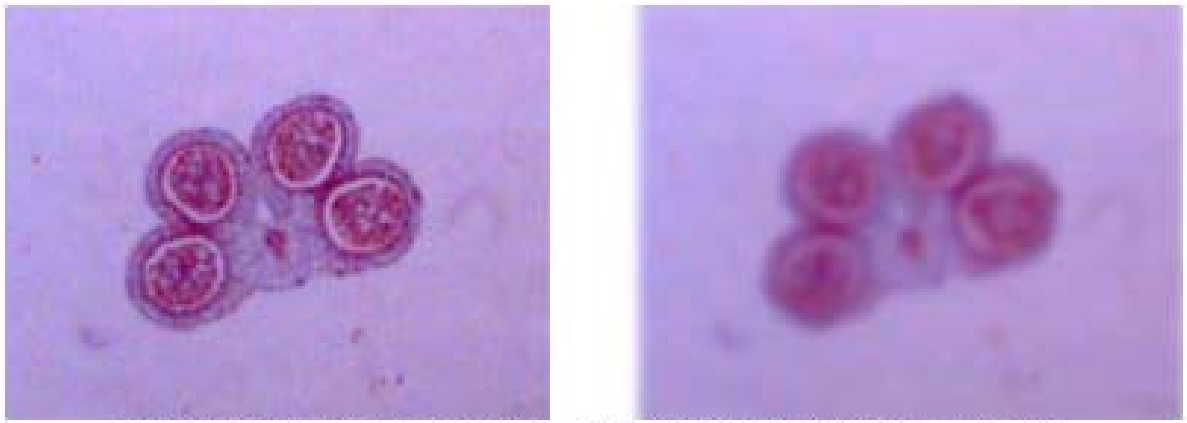


Image of pollen grain in focus (left) and out of focus (right)

Resolution

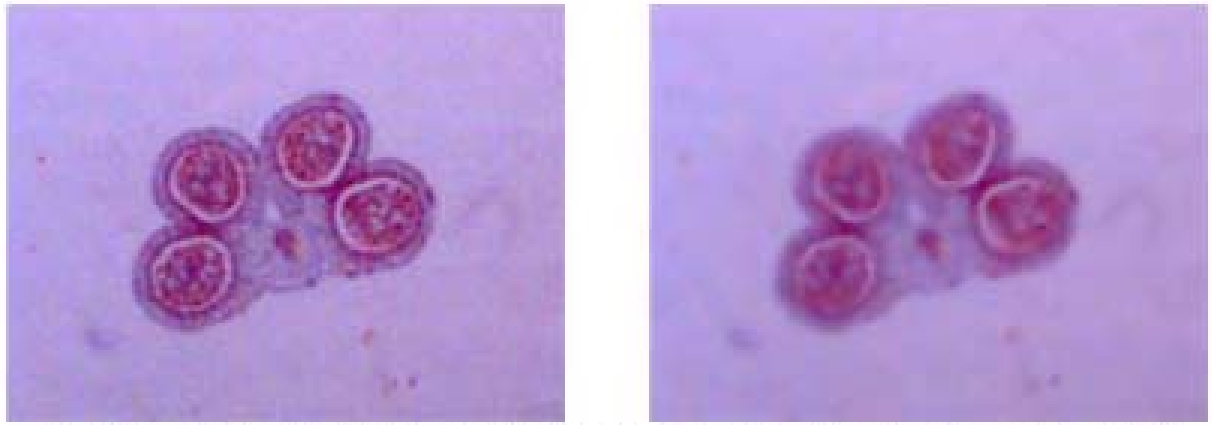


Image of pollen grain with good resolution (left) and poor resolution (right)

Contrast

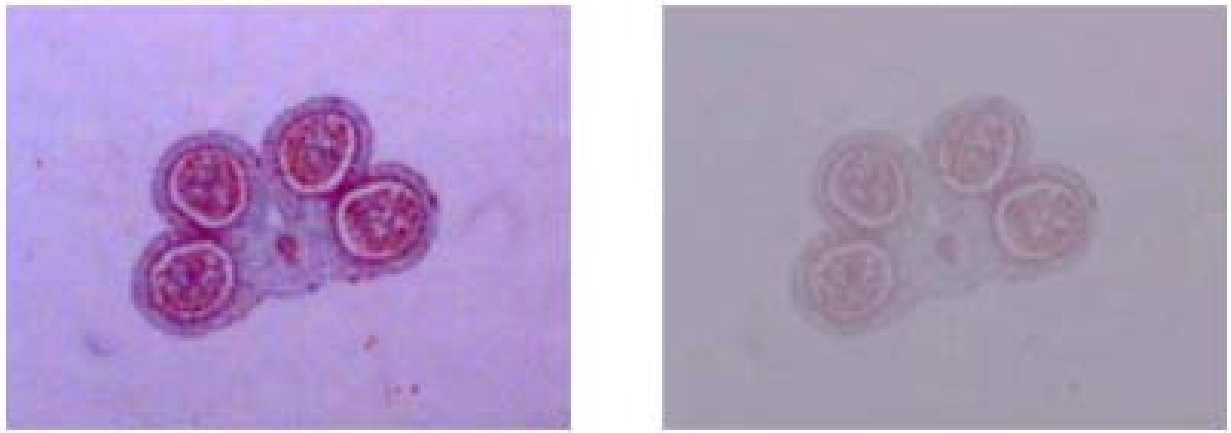


Image of pollen grain with good contrast (left) and poor contrast (right)

Chromatic Aberrations

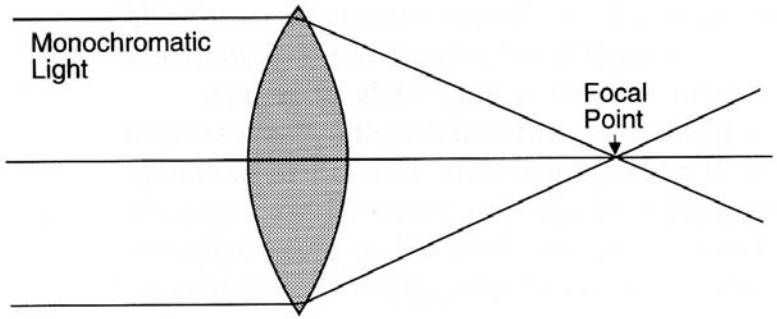


Figure 4-9 Monochromatic light rays are brought to a single focal point by a perfectly constructed glass lens.

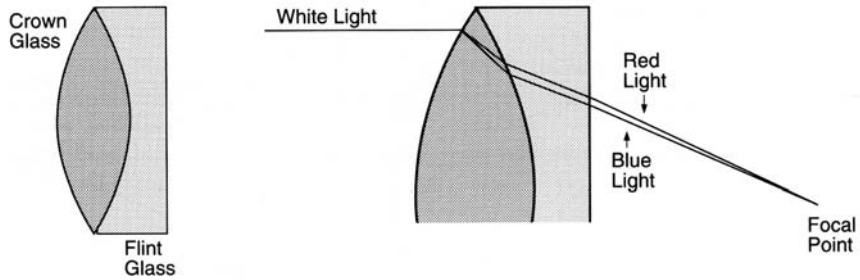


Figure 4-10 Chromatic aberration in a glass lens can be minimized by combining a converging and diverging lens of the correct strengths so that the light rays are brought to a single focal point.

광학현미경의 색수차 보정

1. 단색광 장치(monochromator)를 사용하여 단색 혹은 좁은 파장의 빛만 렌즈를 통하면 색수차가 보정된다.

2. 서로 다른 굴절률을 가지는 렌즈들 (converging and diverging lens)을 함께 사용하여 색수차 보정

Spherical Aberrations(구면수차)

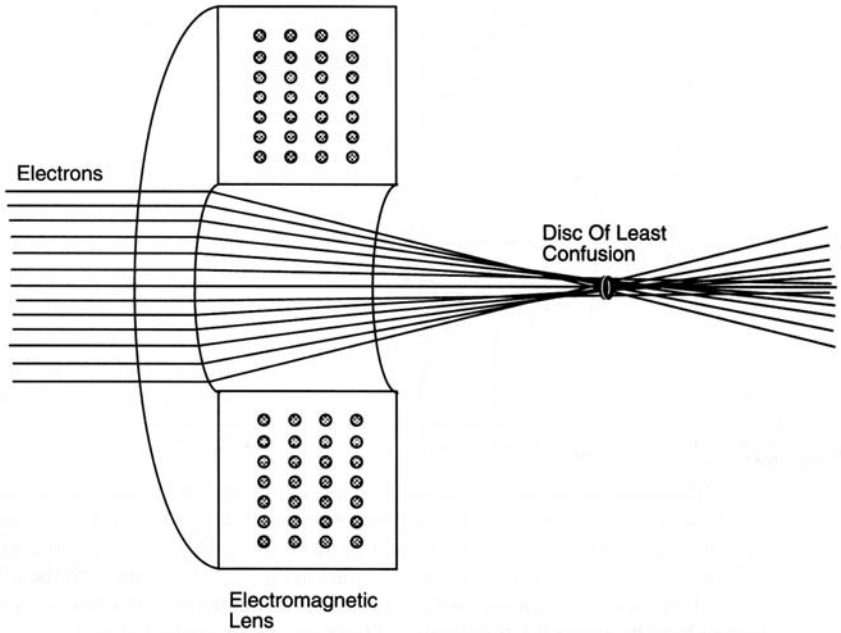


Figure 4-3 Electrons of equal energy passing through an electromagnetic lens are brought to different focal points. The closer the electrons are to the windings, the more the electrons are deflected by the magnetic field and the closer the focal point is to the lens.

구면수차는 연속적인 **focal point** 를 가지며 이들 **focal point** 중 가장 작은 **electron beam diameter**를 가지는 부분을 **disc of least confusion(circle of minimum confusion)**이라 한다

전자현미경의 해상도는 **electron beam** 이 가장 작은 **diameter**의 **focal point**를 가질 때 가장 크다.

Electrostatic Stigmator

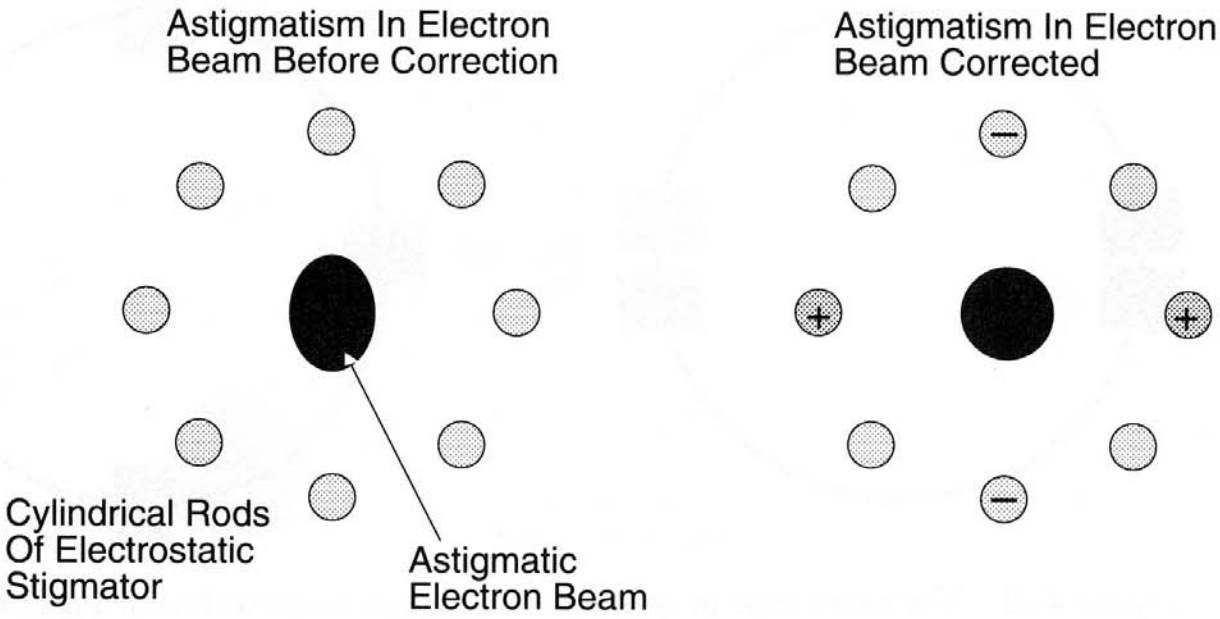


Figure 4-19 An electrostatic stigmator used to correct astigmatism of the electron beam by applying an electrostatic field to push and pull the electron beam into a circular cross section.

Stigmator: 전자빔의 비점수차**(astigmatism)**를 보정하는 장치

-찌그러진 전자빔을 **circular beam**으로 만든다**.**

-정전기적**(electrostatic),** 자기적**(magnetic) stigmator**로 나누어짐

Correction of aberrations

All aberration corrections are designed to reduce in size of the disc of least confusion.

Corrections of chromatic aberration

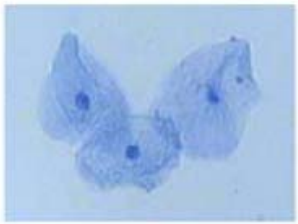
- Combining lenses of different shapes and refractive indices
- Eliminating the variation in wavelength from the light source by using filters and special lamps.

Corrections of astigmatism

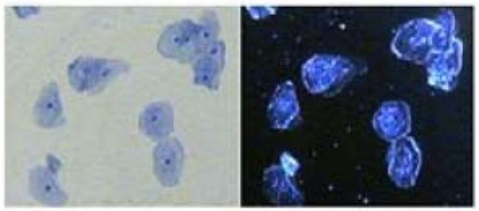
It can be corrected relatively easy in electron microscope, because the magnetic lens strength can be adjusted in two perpendicular planes.

Contrast is number of shades found in an image. A high contrast picture will have only two shades, black and white. The more shades you have, the less contrast, but more information.

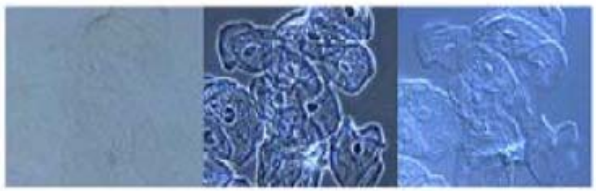
Color is also considered a form of contrast.



Absorption contrast



Diffraction contrast



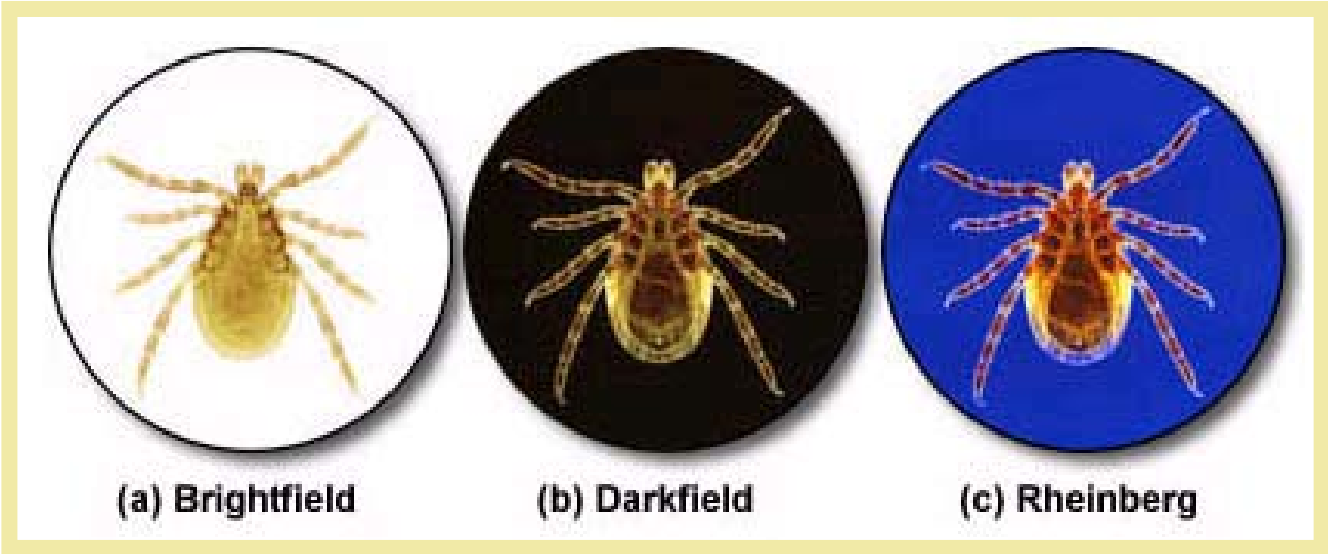
Interference contrast

Contrast & Visibility

Absorption
Reflection
Interference
Polarization
Fluorescence
…..

Observation Modes

- Brightfield - This is the basic microscope configuration This technique has very little contrast.
- Darkfield - This configuration enhances contrast.
- Rheinberg illumination - This set-up is similar to darkfield, but uses a series of filters to produce an "optical staining" of the specimen.



Imaging Modes

- Bright-field and dark-field are the most commonly used examination modes.

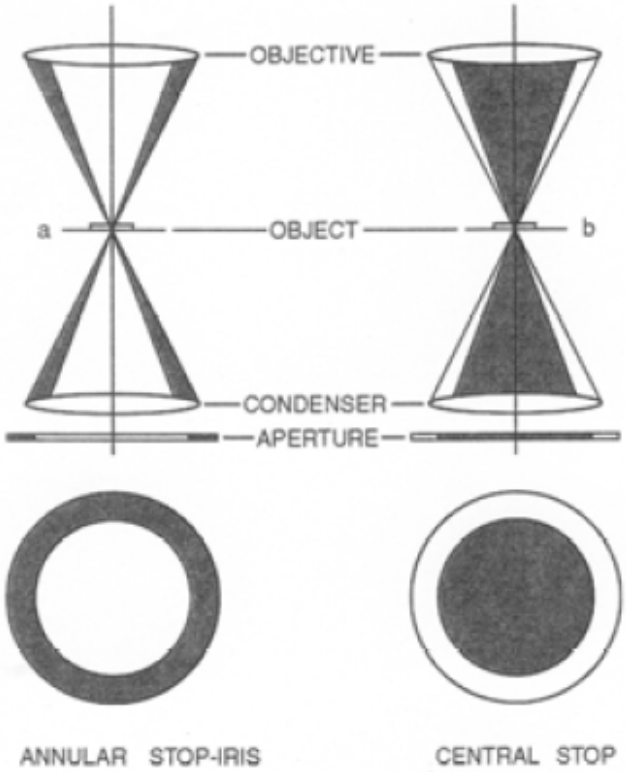
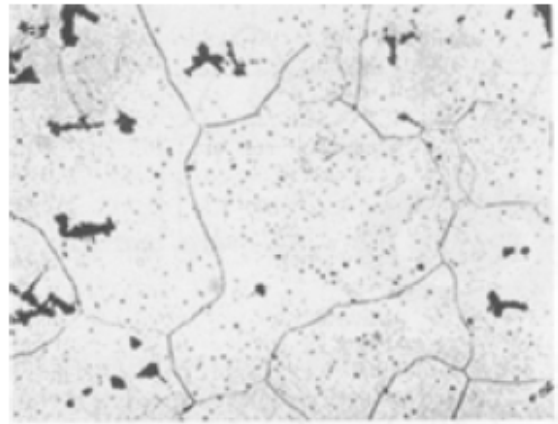
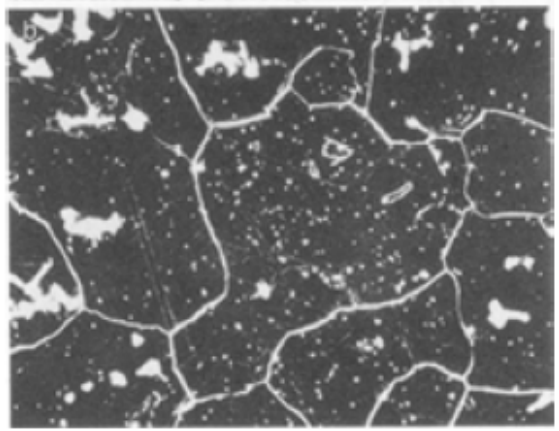


Figure 1.28 (a) Bright-field illumination; and (b) dark-field illumination in transmitted mode. Shaded areas indicate where the light is blocked.

BF



DF



- **Contrast** 조절을 통한 더 많은 혹은 차별화된 정보 얻음

  - Phase Contrast Microscopy
  - Polarized Light Microscopy
  - Fluorescence Microscopy
  - Differential Interference Contrast (DIC)

- Recording The Image

  - Film or Digital

- **Presentation for various optical microscopes**
  - Phase contrast microscope
  - Differential interference contrast microscope
  - Fluorescence Microscopy
  - Multi-photon laser scanning microscope
  - 벡터장 나노 현미경
  - Digital Holographic Microscope