about
microscope optics

RESOLVING POWER

A human eye cannot distinguish two points when these are closer than approximately 0.3 mm or 300 µm to each other. That is what is called "resolving power"; the capacity to resolve two points which are close together or "optical resolution", the ability of an imaging system to resolve detail

MAGNIFICATION

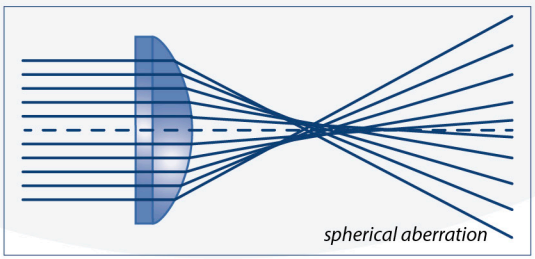
If one needs to detect details of 10 µm, one needs at least 300 µm / 10 µm = 30x magnification in order to resolve this detail. Knowing that conventional stereo microscopes can magnify - without the help of additional lenses and without introducing additional optical aberrations – up to approximately max. 100 times, the smallest detail that a stereo microscope can resolve is 300 µm / 100 = 3 µm

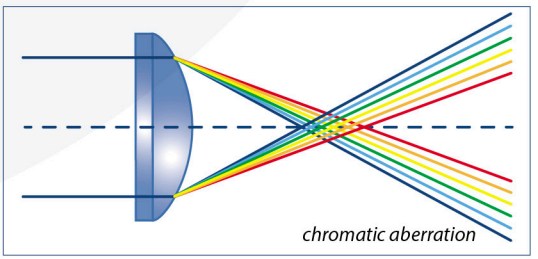
For details smaller than approximately 3 µm, one could better choose an optical compound microscope to resolve these details

OPTICAL RESOLUTION

The resolution of an optical microscope can be defined as the shortest distance between two points that the microscope can reveal for a human eye or camera

The theoretical maximum resolution is limited by the diffraction laws of physics and is equal to
r = 1.22 λ / (N.A. of objective + N.A. condenser)
with r = resolution, N.A. = numerical aperture,
λ = imaging wavelength





ABERRATIONS

In practice, the resolution of a microscope is lower than the theoretical resolution due to optical aberrations, improper illumination or bad alignment of the optics and components of the microscope. Despite corrections for chromatic and spherical aberrations, coma, astigmatism and distortion, the real maximum resolution of a microscope with a 100x objective is about 0.25 µm for 550 nm light rays

Chromatic aberration	Difference in focus of different colors caused by difference in refractive indices for each wavelength
Spherical aberration	Difference in focus caused by defects or irregularities on the surface of a lens
Astigmatism	Rays traveling through two perpendicular planes having different focal planes
Coma aberration	Variation in magnification over the entrance pupil
Distortion	Stretching of an image as a variation in magnification across the lens field

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