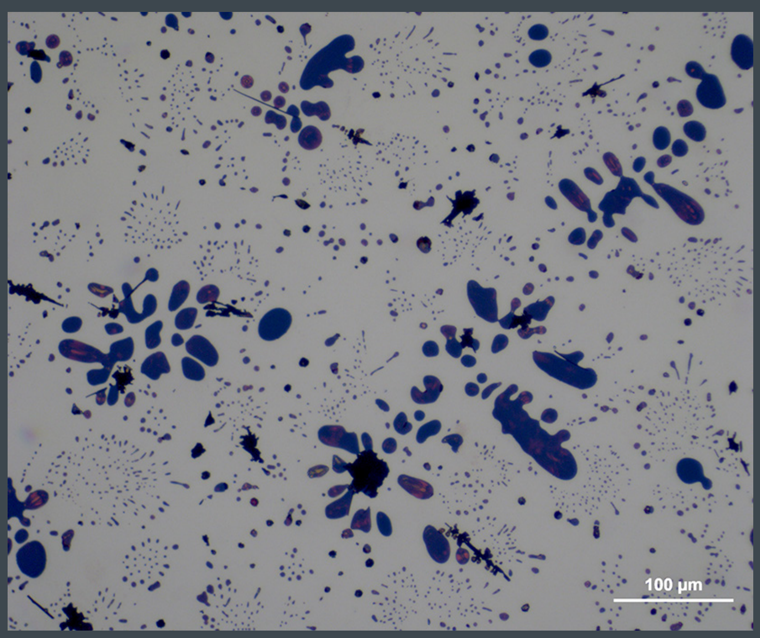
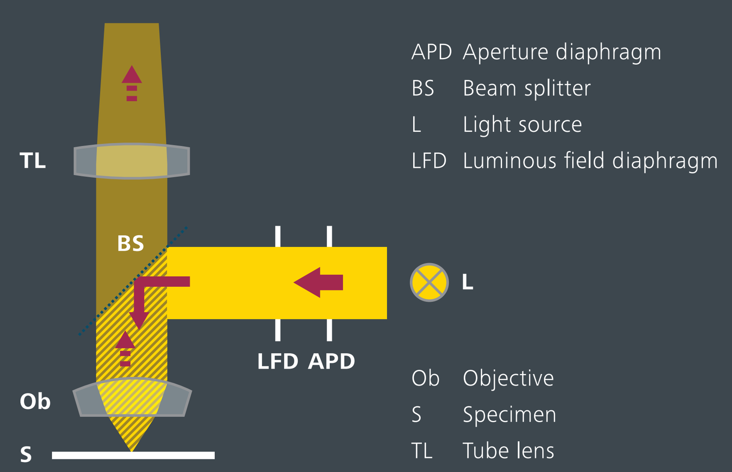
Light Microscopy Contrast Methods for Materials Research

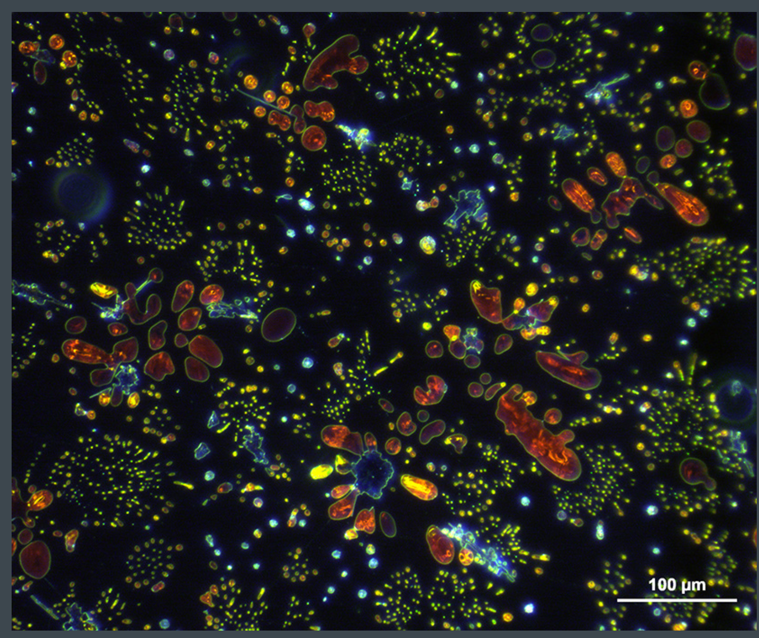
Brightfield

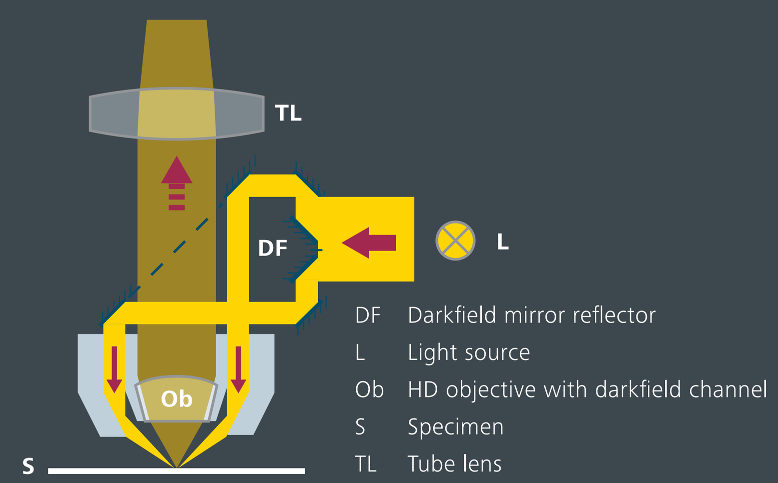




Brightfield contrast is the most common contrast method in light microscopy. Details of a sample are distinguished by the different reflectance of the materials in the specimen. This generates the typical image of a dark or colored sample on a bright background. Compare the above image of copper with oxide.

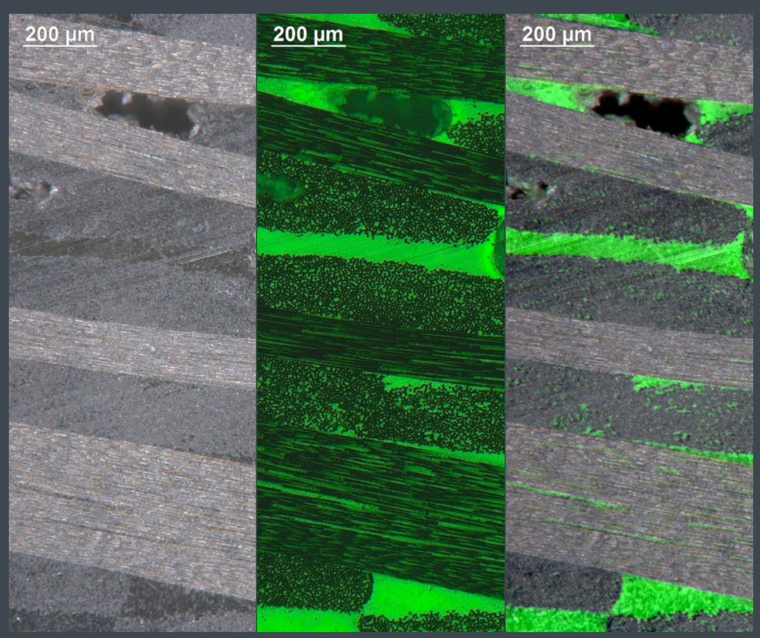
Darkfield

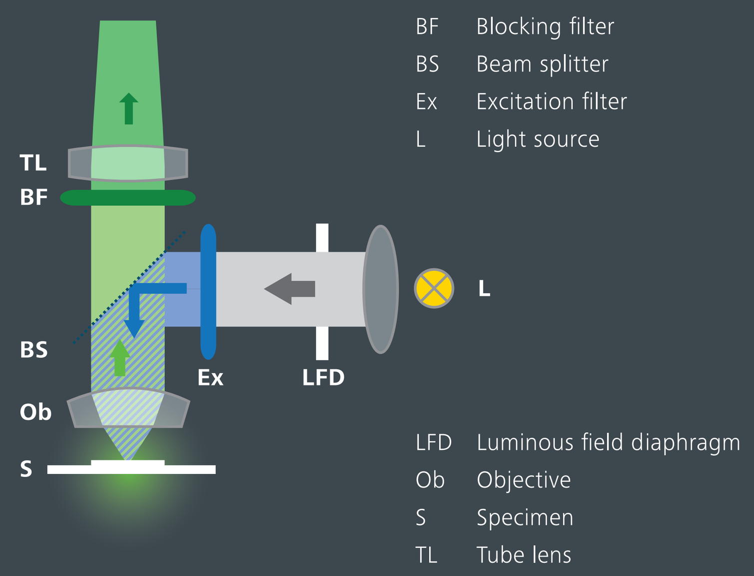




In Darkfield contrast, the sample is illuminated under an angle. As a result, only the diffracted light is detected and leaves the background dark. This method is particularly suitable for visualizing edges, scratches, and other surface topographies. In addition, semi-opaque phases are identified by its color. Compare the semi-opaque phase of copper oxide inclusions that appears in garnet red color in the image above.

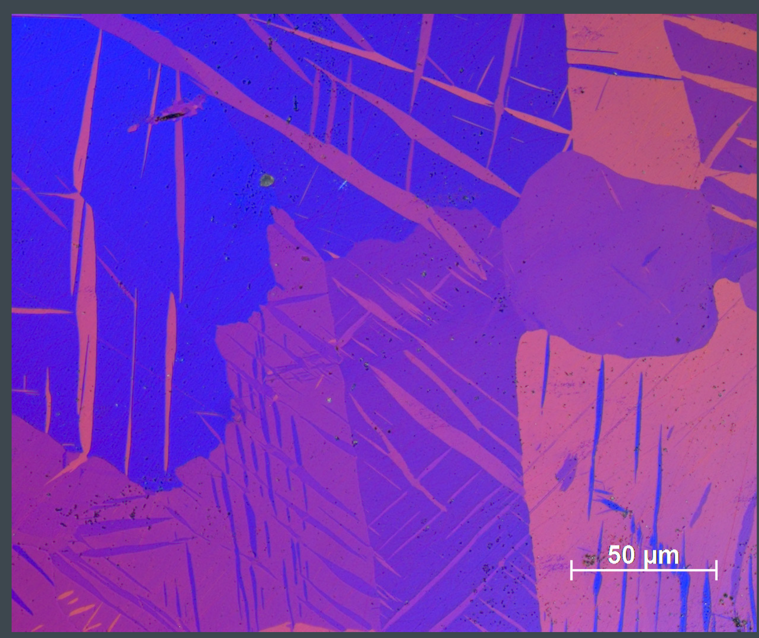
Fluorescence

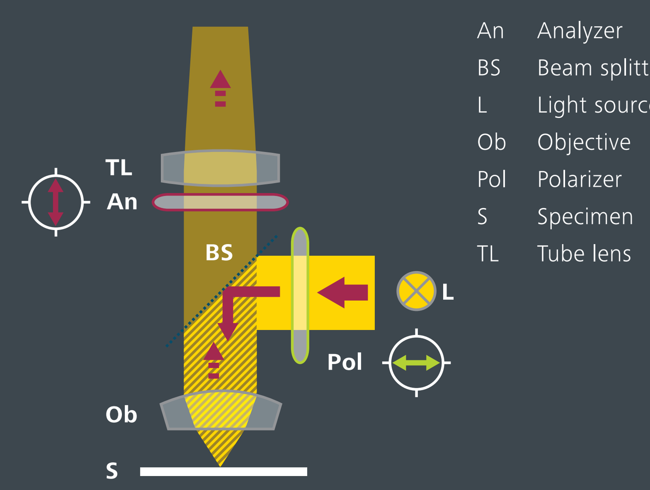




Fluorescence contrast is used in various applications like failure analysis, defect location or material analysis. Materials with fluorescence properties absorb light of a certain wavelength and emit it again at a different wavelength. The image above shows a carbon reinforced composite where specific areas, here the polymer matrix, are made visible with fluorescence. This technique requires a capable light source, filters to specify and separate your excitation and emission light, and a camera.

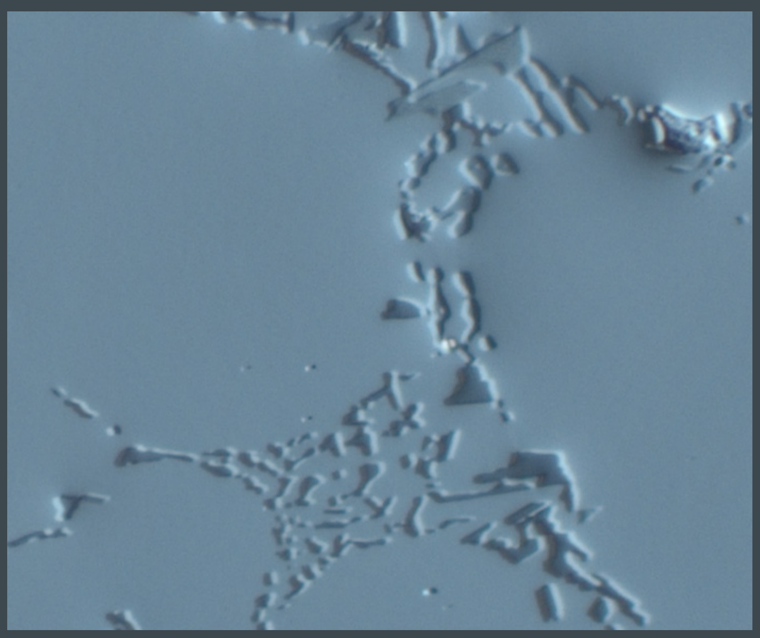
Polarization

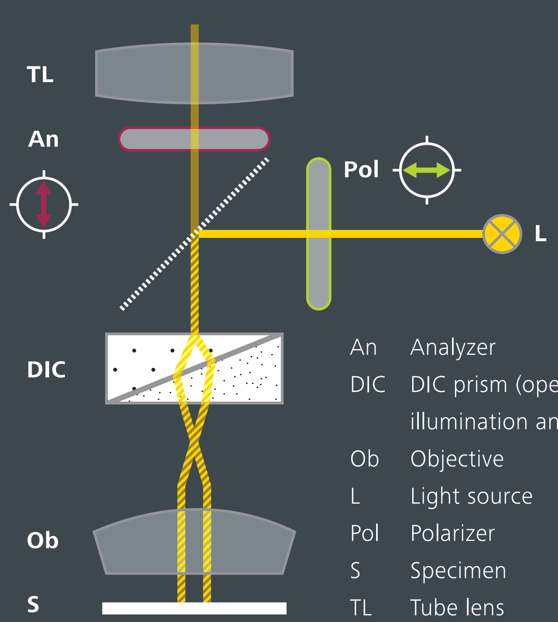




Polarized light is used in transmitted and reflected light to detect crystal-like (birefringent) structures within all types of samples. When polarized light interacts with a sample, the polarization direction of the light is influenced. This effect can be used to visualize domains of different crystalline orientation. The image above shows a zinc sample – a material used in corrosion protection. A polarizer and an analyzer are required to perform polarization microscopy.

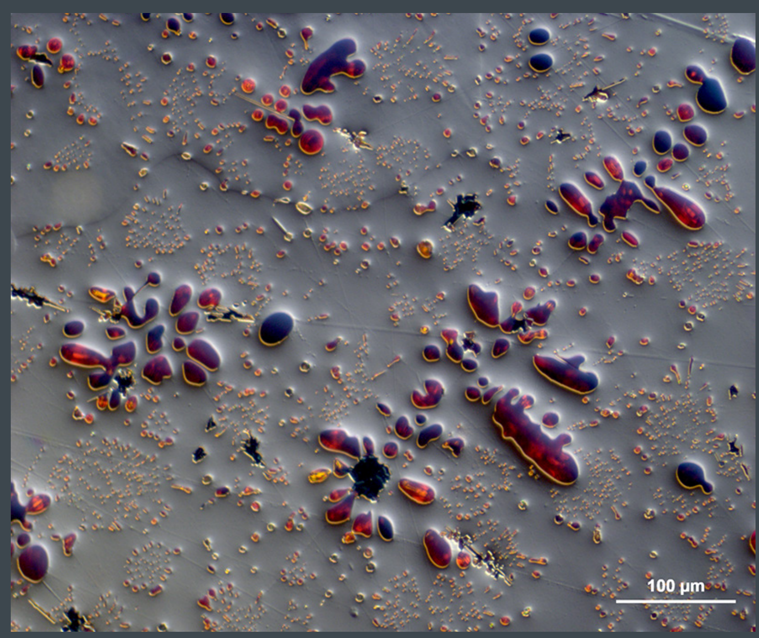
Differential Interference Contrast (DIC)

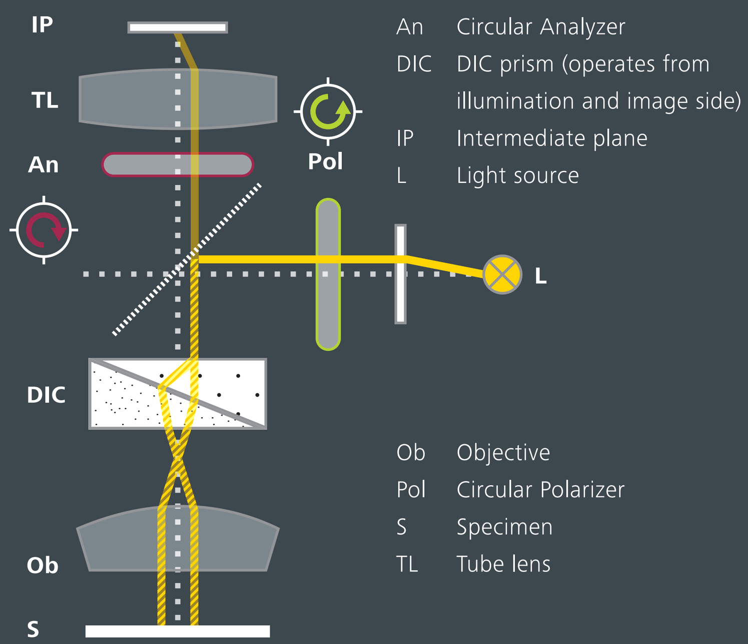




DIC is the most common method to visualize surface topography such as slopes, valleys, and other discontinuities or to check surfaces for defects, natural or preparation induced. It adds contrast to the image by evaluating the optical path length difference at surface structures using interferometry. DIC enables the visualization of even small surface structures due to the slightly dissimilar optical path length in the object. Compare the image of cast aluminum above.

Circular Differential Interference Contrast (C-DIC)





With C-DIC very fine structures, errors and defects can be displayed with high contrast – structures that would produce no or insufficient contrast in classical brightfield or darkfield. Unlike standard DIC, C-DIC uses circularly polarized light. This results in better contrast and resolution. In order to change the shear direction, you only need to turn the C-DIC-slider, not the specimen, resulting in comfortable handling. Compare the image of copper above where fine surface structures can be observed with high contrast and resolution simultaneously, independent of orientation.

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Seeing beyond