

Color Metallography

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THE USE OF COLOR in metallography has a long history, with color micrographs published over the past eighty-some years. A number of general articles (Ref 1–15) have been published reviewing methods and applications.

Natural color is of use in only a few classic metallographic applications. Prior to the devel-

opment of wavelength-dispersive spectrometers and energy-dispersive spectrometers used on electron microprobe analyzers and scanning electron microscopes, the color of inclusions using different illumination modes was part of the identification schemes used. However, natural color has limited applicability.

Color can be created by optical methods, such as with polarized light and differential interference contrast illumination. Polarized light examination is extremely useful for studying the structure of certain metals, without etching, that have noncubic crystal structures, such as beryllium, hafnium, α -titanium, uranium, and zirconium. In many cases, polarized light can be used with etched specimens, regardless of their crystal structure, to produce color. Differential interference contrast reveals height differences between constituents and the matrix, but in most cases, the color is of esthetic value only.

Color etching methods are widely used, although they are not universal. Color etchants have been developed for a limited number of metals and alloys, and they are not always easy to use, nor are they fully reliable. Color etchants are used by immersion or electrolytically. A complete listing of all color etchants is beyond the scope of this article, but good compilations are available (Ref 7, 10–15). Aside from the immersion tint etchants, there are a number of older

etchants that produced color either by immersion, sometimes in boiling solutions, or electrolytically. Historical information on these etchants can be found in Ref 16.

Tint etchants may color either the anodic (matrix) or cathodic constituents. There are also electrolytic reagents known as anodizing solutions. They have been used most commonly with aluminum and its alloys. These solutions may produce a thin film on the surface, with a degree of roughness. Examination in bright field reveals little, but polarized light reveals the structure clearly.

There are other procedures to create interference films using heat (heat tinting), vapor deposition, or by reactive sputtering. Color can be observed with bright-field illumination but often can be enhanced using polarized light.

Optical Methods for Producing Color

There are few instances where naturally occurring color differences are observed in metallic systems. Specimens plated with copper or gold are a common example. There are two main optical methods for producing coloring: polarized

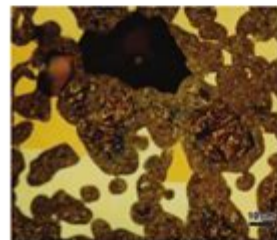


Fig. 1 Microstructure of a porous high-carbon steel powder metallurgy specimen infiltrated with copper showing the natural color of the copper, which is easier to see when the steel has been tint etched revealing coarse plate martensite and retained austenite



Fig. 2 Microstructure of as-cast Au-22%Al showing the "purple plague," AuAl₂ intermetallic, needles, surrounded by the Al-AuAl₂ eutectic after polishing to a 1 μ m finish. Magnification bar is 50 μ m long.



Fig. 3 Cuprous oxide in high-pitch arsenical copper (hot extruded and cold drawn) viewed in dark field, revealing the classic ruby-red color. Magnification bar is 10 μ m long.

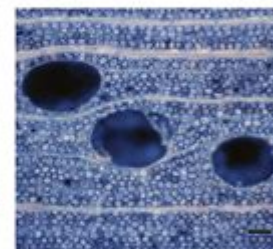


Fig. 4 Microstructure of walnut (plane perpendicular to the trunk axis) showing the cells and pores revealed using dark-field illumination. Magnification bar is 100 μ m long.

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