

METALLOGRAPHIC STUDY

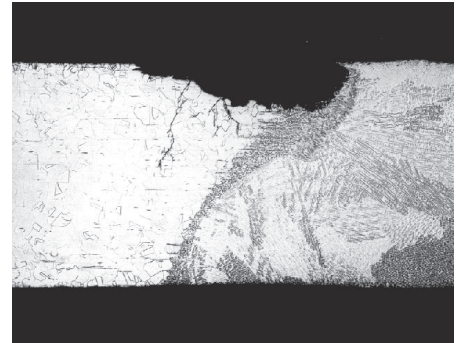
DESCRIPTION OF TECHNIQUE

Metallographic study, or metallography, is the imaging of topographical or microstructural features on prepared surfaces of materials. The structures studied by metallography are indicative of the properties and performance of materials studied.

In this technique, planar surfaces are prepared to obtain a polished finish. Chemical or other etching methods are often used to delineate macrostructure and microstructure features. Once prepared, samples are examined by the unaided eye, light microscopy, and/or electron microscopy. (See sections on Light Microscopy and Scanning Electron Microscopy.)

Samples for microstructure evaluation are typically encapsulated in a plastic mount for handling during sample preparation. Large samples or samples for macrostructure evaluation can be prepared without mounting. Sample preparation consists of grinding and then polishing using successively finer abrasives to obtain the desired surface finish. For microstructure examination, a mirror finish is needed, but a finely-ground finish is adequate for macrostructure evaluation. Etchants are specially formulated for the specific sample material and evaluation objectives.

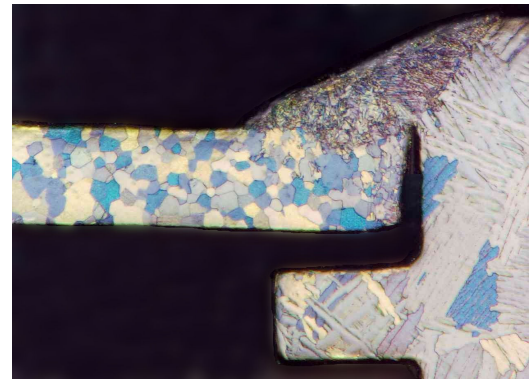
Sampling for metallography can be a random section to evaluate representative bulk properties or a section in a specific location to characterize localized material conditions. For example, a section through the failure initiation site is often made to assist with a component failure analysis. For micro-electronic components, precision metallographic methods can obtain sections through specific wire bonds, solder pads, or even individual components on an integrated circuit device.



Stress Corrosion Cracking at SS Weld

ANALYTICAL INFORMATION

Macrostructure Evaluation - Deep chemical etching is used to characterize large-scale variations in material composition, structure, density, etc. This method is useful for evaluation of welds, brazes, forgings, and polymer-matrix composites for configuration, defects, and structure.

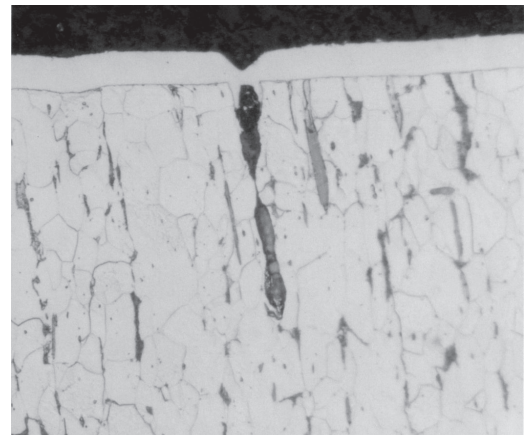


Microstructure of Welded Titanium

Microstructure Evaluation - Characteristic features provide information about composition, phase distribution, mechanical and physical properties, thermo-mechanical process history, and defects. In failure analysis, the morphology of corrosion or cracks can be characteristic of the failure mode.

Quantitative Metallography - Observed features can be analyzed to obtain measurements of microscopic characteristics, including grain size, phase volume fractions, and linear dimensions. Measurements are made manually or by computerized semi-automated methods on digitally-acquired images.

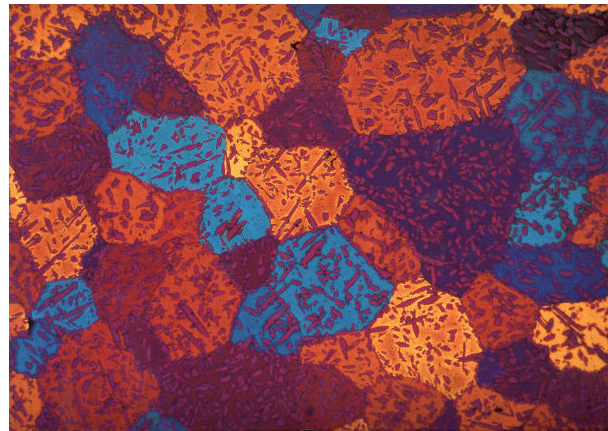
Field Metallography - Metallographic examination can be performed in situ for large components or on structures in the field. The selected areas of the sample surface are polished using portable tools. The prepared surface can be examined directly with a portable light microscope. Alternatively, the surface can be replicated with an acetate tape or castable polymer for examination by light microscopy or electron microscopy in the laboratory.



Plating Defect Caused by Chemical Attack Before Plating at Nonmetallic Inclusion

TYPICAL APPLICATIONS

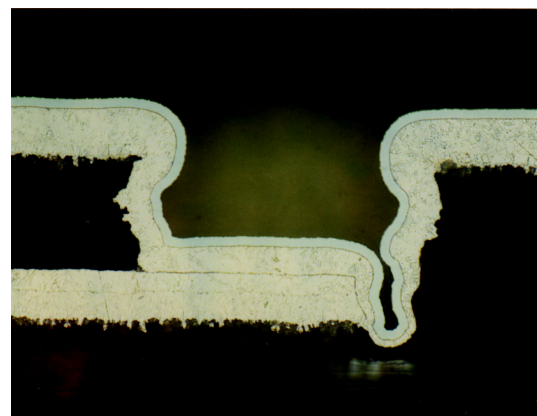
- Metal alloy heat treatment verification
- Coating thickness measurement
- Weld or braze joint evaluation
- Case hardening depth determination
- Corrosion resistance evaluation
- Failure analysis
- Microscopic defects in IC devices
- In situ evaluation of thermo-mechanical degradation



Manganese Bronze Microstructure

SAMPLE REQUIREMENTS

Most samples are sectioned and encapsulated in a metallographic mount to facilitate preparation. The mount sizes range from about 1 in. (25 mm) to 3 in. (75 mm) in diameter. Sections up to approximately 8 in. (200 mm) across can be prepared in the laboratory without mounting. Localized areas on large samples or those that cannot be cut are prepared in situ and evaluated using a field microscope or replicas of the prepared surface.



Mis-registration in Multilayered Circuit Board