TCR Advanced Engineering P. Ltd

Experts in Metallography, Failure Investigation and RLA

Metallurgy for Industries

Power | Petrochemical | Fertilizer | Chemical | Refinery | Engineering | Automobile

A Monthly News Letter May, 2013 **Volume 06**

Microstructure Characterization:

Importance of image analysis for metallurgical evaluation

Microstructure of any material carries vital information about metallurgical condition. For a novice, microstructures of metal look like presence of different shades cast by the phases. A more conversant examiner would be able to estimate fraction of area covering phases and grain shapes. Generally, for instance, plain carbon steels display ferrite and pearlite shades; low alloy steels can be seen with presence of carbides / bainite / martensite as the case depending on alloy content. Only a person with hands on experience, having examined thousands of microstructures can discern the key quantitative characteristics and heuristically interpret the condition of material.

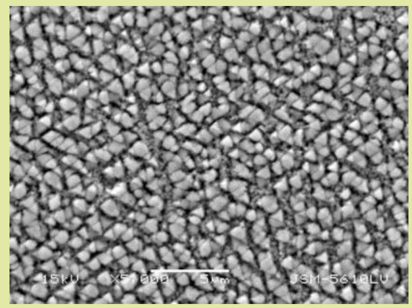
Quantitative metallography has played a vital role in materials science and engineering. It is helpful to correlate processes with microstructures and mechanical properties, and furnish the first hand data to formulate a pragmatic mathematical model.

The manual quantitative metallography is often difficult, tedious and time-consuming. To overcome these limitations, a computer assisted quantitative analysis is sine-qua-non. Several well known soft wares such as 'Corel draw' and 'Adobe Photoshop' have been commercially developed to enhance image quality. However, these softwares are of generalized nature and cannot be directly used in quantitative metallography. TCR Advanced has developed unique software 'MiC'- especially meant for the quantitative analysis of microstructures.

As against the conventional (manual) methods, the use of computerized software by MiC, offers much more flexibility; it can perform measurements automatically with minimal operator assistance.

Microstructure of the Month

• • •



Magnification:*5000X*

Etchant :10%Cro3

MOC: Inconel 738LC

Component: Gas turbine blade

Observation: is the high magnification view of the gamma prime precipitates. Their morphology is cuboidal / triangular in shape.

Useful hints: Morphology of gamma prime determines the useful service life of the component. Metallography approach determines the remaining life of the blade and also indicates the possibility of rejuvenating the costly gas turbine components.

TCR Advanced Engineering P. Ltd

Experts in Metallography, Failure Investigation and RLA

Metallurgy for Industries

Power | Petrochemical |Fertilizer| Chemical | Refinery| Engineering| Automobile

A Monthly News Letter May, 2013 **Volume 06**

Grain size measurements:

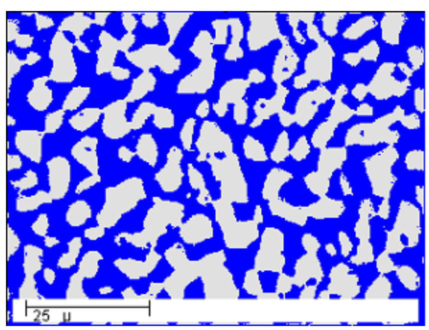
When polycrystalline material is seen under the microscope, the regions that look homogeneous and distinct are termed as grains. Grain size is usually estimated or measured on the cross section of an aggregate. The common units are Average diameter, Average Area, Number of grains per linear unit Number of grains per unit area, and Number of grains per unit volume. However, most common designation of the grain-size is given by ASTM Grain Size 00 to 12, where lower number indicates larger grains. The effect of grain size on mechanical strength, high temperature creep properties, corrosion resistance is quite significant. It is sometimes essential to know the uneven grain distribution within the same material. For example in boiler tubes – localized larger grains are clear indication of temperature excursion, or burner / flame malfunction.

Grain size is one of the important parameters in characteriinge the microstructure. It can set up the quantitative relation between the microstructure and mechanical properties for example, the Hall-Patch equation:

$$\sigma = \sigma_0 + kd^{-\frac{1}{2}}$$

Where
σ is flow stress,
$\sigma 0$ is lattice friction stress,
k is constant and d is grain size.

Volume fraction measurements:



Solarized image of austenite phase in duplex steel

The phases in the materials generally throw different shades and shapes. It is important to measure the quantity of typical phases, nuances in microstructural features to ascertain the aging condition of the material with respect to available statistical data..

- For example, Pearlite in plain carbon steels is shaded darker; lesser its content would make the steel softer with lower mechanical strength.
- The presence of carbides in micro alloyed-high temperature resistance steels improves creep strength.
- The presence of grain boundary carbides on the grains of series 300 stainless steel has detrimental effect on corrosion resistance.

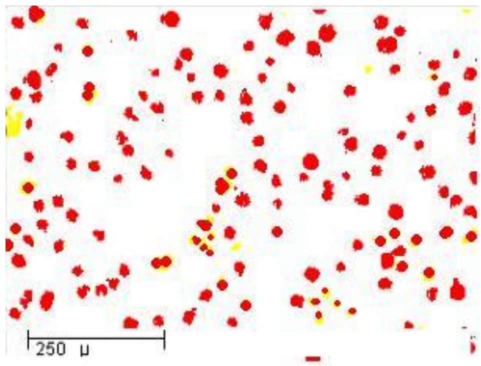
TCR Advanced Engineering P. Ltd
Experts in Metallography, Failure Investigation and RLA

Metallurgy for Industries

Power | Petrochemical |Fertilizer| Chemical | Refinery| Engineering| Automobile

A Monthly News Letter May, 2013 **Volume 06**

Nodularity measurement:



Identification of Nodules in casting sample in As-polished condition.

Nodularity of cast irons refers to a percentage of nodular (rounded) graphite particles in microstructure to total number of graphite particles. Higher the nodularity more is the ductile Iron's ductility. Different grades of cast irons despite their damping, good wear resistance and other properties, possess poor toughness. Malleable cast irons are intermediate with regard to properties like wear and toughness. The measure of nodularity is therefore a useful criterion for acceptance / rejection of material. The image analysis software 'MiC' has built-in shape identifier engine that works on the principle of two-dimensional projection of particles. Graphite particles possess different morphology. For qualifying them to be nodular, their two dimensional projection is compared to the normal circularity index. The result is generally very quick in comparison to manual method of multi-frame analysis, and it is reproducible.

Coating thickness measurements:

The components which are induction hardened, surface treated or coated have a distinct outer most layer. Such layers become visible only after specialized etching and microstructural preparation. The measurement of depth of the layer is cumbersome with manual method on microscope and requires specialized, pre-calibrated and expensive eye pieces for direct measurements. However, with the aid of computerized software the necessary measurements can be done even after taking the images. The result are accurate, which can provide statistical analysis on minimum, maximum, average, mean and standard deviations – that are useful for meaningful research work. For example, an automobile engine component with carburized layered steel would provide higher wear resistance and strength with softer core. The degree of carburization can be estimated by layer measurements through microstructural examination. The implication of lower or higher thickness of the layer could be correspondingly less wear resistance or more brittleness. Such computerized data would certainly useful in a research work, meant for optimizing case/coating depth

For Further details Contact us at testing@tcradvnaced.com , Ph: +91-265-2657233

* * *