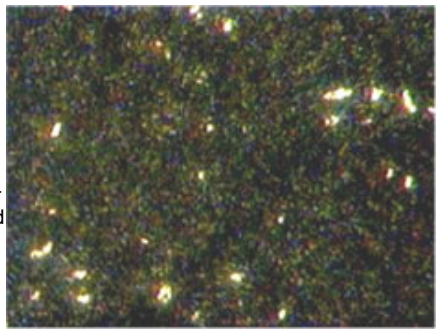
Microstructrure of the Month

Presented below are the monthly informative articles for today's metallurgists and engineers by TCR Advanced Engineering. TCR Advaned Engineering, located in Vadora, India is a franchise of TCR Engineering Services, Mumbai, India. TCR are experts in metallography and failure analysis investigation.

TCR Engineering and TCR Advanced Engineering can be reached via the web by visiting the "Contact TCR" page.

Each month, engineers from the Metallography and failure analysis division highlight an issue that may help prevent future application or product failures.

January 2006

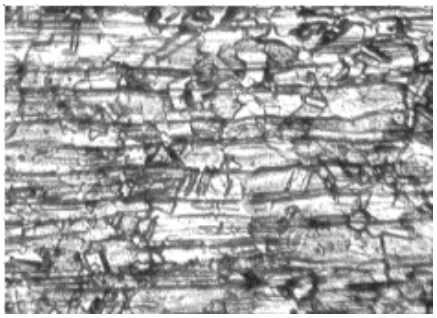


MOC:X20Cr13 (Cutter blade)-tool steel
Etchant: First Electro polish and Copper deposition
Magnification: 500X

Observation: Microstructure shows fine tempered martensite structure with lumps of retained austenite (shiny regions) Normally observed with, tool steel, die steel, bearing steel, spring steel etc

Useful Hits: Retained austenite is normally unwanted "phase" observed after hardening and tempering in medium, high carbon, and alloy steels. The word it self explains that austenite is retained up to room temperature at local regions. Retained austenite is a metastable phase and over a time it decomposes in to martensite and forms cracks. It is responsible for premature failure of hardened and tempered components, with reduced life. Microstructure check would provide watch on heat treatment aspect. The limitation of microstructure technique is that it does not give accurate% of the RA, for that X-ray diffraction is the correct method. However microstructure provides reasonable guidelines on RA check for quality control and provide clues towards cause of failure.

April 2005

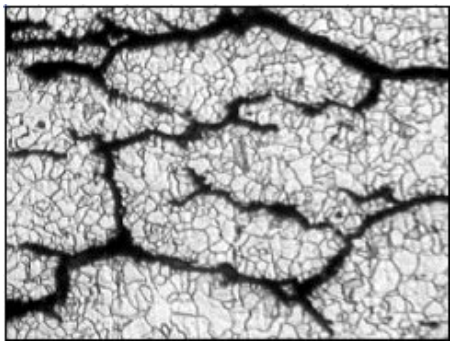


MOC: ASTM A 335 Grade P1
Magnification: 100X
Etchant: 2% Nital

Observation: Microstructure shows ferrite grains with cracks. It shows decarburization and fissuring due to a Hydrogen Attack on the material.

Useful Hits: When hydrogen gas handled at high temperature (normally above 200 degree Celcius) and at high pressure, it penetrates in the steel in the nascent form and reacts with carbon to form methane gas. This methane gas produces cracking in the steel. This phenomenon is known as Hydrogen Attack. Microstructure examination is useful to monitor damage in hydrogen related service and useful tool to find out in-service degradation. Further it helps in selecting a proper allow for the service.

January 2005

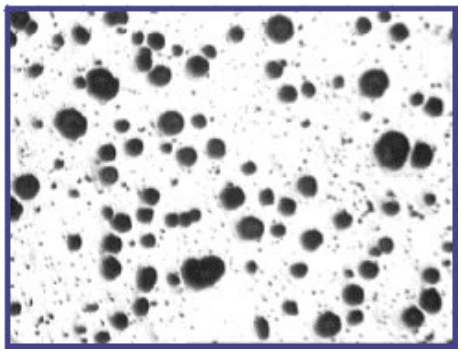


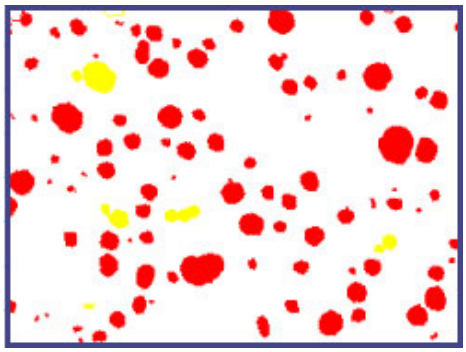
MOC: SS 304L (Plate 5 mm thick)
Magnification: 325X
Etchant: 10% Oxalic Acid (Electrolytic Etching)

Observation: Microstructure shows austenite grains with presence of heavy strain lines in the direction of rolling/forming. No carbide precipitation is seen.

Useful Hits: Normally for "300 series" austenite stainless steel microstructure is observed for carbide precipitation. If carbide precipitation is not observed then the material is considered acceptable under microstructure test. Presence of strain lines indicates the effect of mechanical working and higher internal stresses in the stainless steel. This internal stresses will help in promoting pitting and stress corrosion cracking, under corrosive condition. We from TCR always point out this aspect whenever we check microstructure for austenitic stainless steel, and if the application for SS is know we do not accept microstructure for stainless steel with such strain lines. Such efforts are appreciated by our end users.

December 2004





MOC: Nodular Cast Iron
Magnification: 100X
Condition: As Polished
Nodularity: 94.23%

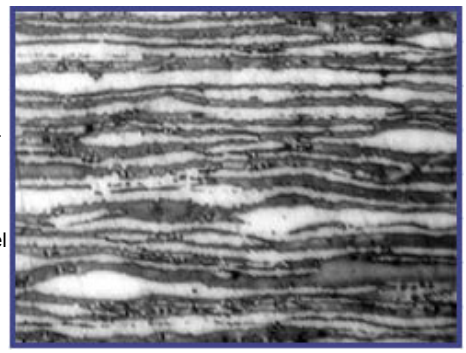
Observation: Microstructure shows presence of regular and irregular graphite nodules.

% Nodularity was measured by the Automation Image Analyzer Software (MIC) at the TCR Engineering Services Material Testing Laboratory in Mumbai, India.

Useful Hits: Nodular cast irons is used for High strength/ductility castings - lever, cams, frames, etc.. for engineering components. Proper check with the use of Automation Image Analyzer Software would help in monitoring consistent quality, as graphite shape is sensitive to casting techniques and/or process.

November 2004

MOC: SAF 2205-UNS S31803
(Duplex Stainless Steel Tubing)
Magnification: 1000X
Etchant: Emmmanuels's Regent

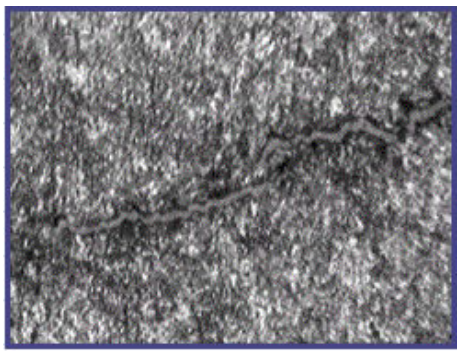


Observation: Microstructure shows elongated ferrite and austenite grains. The ferrite and austenite is approximately in equal proportion.

Useful Hits: Duplex stainless steel is tomorrow's work horse. As is has inherent advantages of SCC (Stress Corrosion Cracking) resistance over 300 series of Austenitic stainless steel. By definition duplex stainless steel would aggregate to approximately 50% ferrite and 50% austenite in the microstructure. This steel are vulnerable to formation of harmful phases like chi, lave and sigma in the microstructure during manufacturing. Microstructure examination from distribution of phases, and presence of harmful phases is very important for reliable service life.

October 2004

MOC: EN-8 (Forged and Hardened)
Magnification: 300X
Etchant: 2% Nital



Observation: Microstructure shows presence of cracks filled with oxide scale in the matrix of tempered martensite. These are typical quench cracks. The cracks have formed at the time of quenching and subsequently got oxidized during tempering.

Useful Hits: During the hardening stage there are chances of formation of quench cracks which opens under operational stresses and leads to inferior performance and premature failure of components. Microstructure examination can find out the nature and cause of the crack so preventive action can be made.

Additional Information:

TCR has completed more than 300 failure investigation assignments, including 50 major projects on manufacturing or metallurgical failure analysis on ASME boiler and pressure vessels, Aircraft /Aerospace, Gas turbine engine components, Oil and gas transmission pipelines, Food processing equipments, Heat exchangers, Medical supplies, Automotive components, Refineries, Petrochemical plants, Offshore structures, Industrial machinery, Weldments and Ships.

TCR's failure analysis strength is in evaluating high temperature and high pressure failures. The Failure Analysis Team at TCR Engineering has experience in the materials, failure analysis, metallurgical, welding, quality assurance, and forensic engineering fields and is conducted by engineers holding advanced degrees in metallurgy, and mechanical, civil, chemical, and electrical engineering.

The Failure analysis team is backed by our well-equipped material testing laboratory in Mumbai, India. Founded in 1973, TCR Engineering is India's foremost NABL and ISO 17025 accredited independent material testing laboratory. TCR tests ferrous and non-ferrous metal, casting & forging, sheet metal, bar, pipe, stainless steel, nuts, bolts, engineering goods, non-metallic materials such as polymer, ceramic, glass, machined parts, and machine tool components as per international specifications or client-specified standards.

To know more about our failure analysis and associated company information, please download our technical whitepapers from our failure analysis download corner.