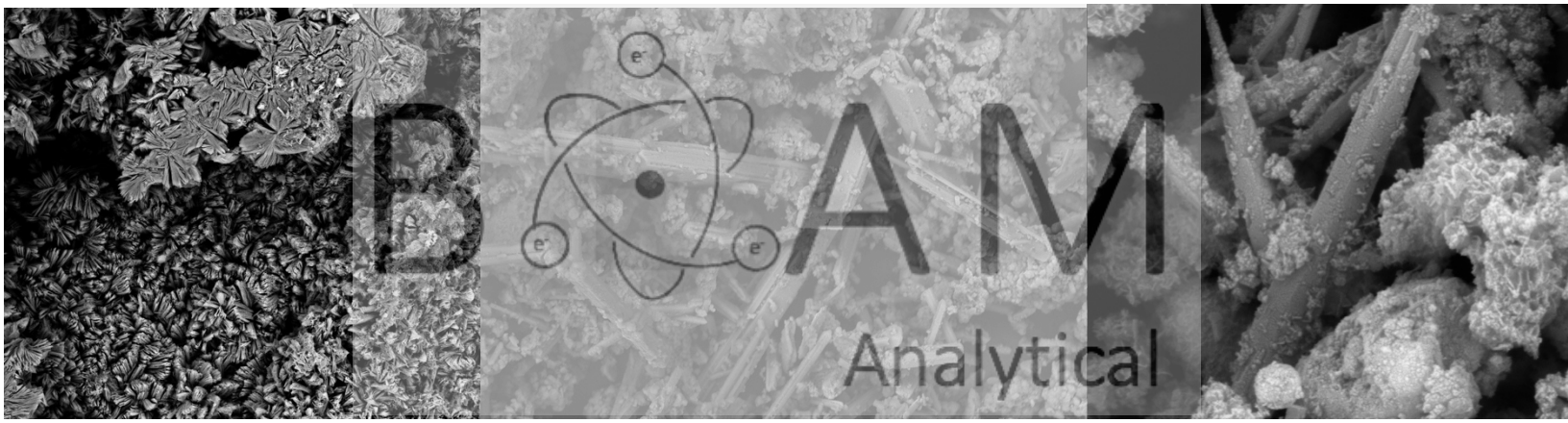


Failure, Inclusion & Corrosion Investigation

When a product does not perform to its specification, the manufacturer needs to evaluate the situation and be able to understand why the failure occurred. There can be multiple or various reasons for products failing. Failure can include but is not limited to corrosion, inclusions, contamination, mechanical strength failure and many more. Failure can cause companies serious issues at any point in the supple chain – especially for the engineering and the manufacturing industries. Root-cause Analysis (RCA) solves the immediate problem and provide information to avoid similar future cases by identifying the origin of the failure in the materials and / or process. This process helps address the true problem instead of attending to the symptoms.

Here at BEAM we have a dedicated microscopy and analyst team who are able to identify many different types of failure, inclusions and corrosion using our extensive expertise, techniques and state-of-the-art equipment. It is of vital importance to identify the source of the failure through analysis and resolve root causes to prevent recurrence. We can help whether the failure has occurred during manufacturing, processing or filling of the product or potentially by the customer after purchase. We provide analysis on a whole range of materials, inclusions and corrosion studies, including glass, plastics, metals and many more.
Please contact us, if you have any tailor-made requirements, require further information, or would like a quote for analysis.

Sample Considerations

Each project is different, and samples will range in size form very small to very large, and BEAM is equipped to handle the full range. Typically, large samples will require sectioning in order to be able to analyze the sample with the chosen technique. Our team will take care of the sample preparation and sectioning for you.

Failure analysis involves metallurgical investigations of equipment, components, coatings, linings and structures (metals & alloys) due to corrosion, environmental degradation and abuse, misapplication of the particular metal. Studies of failure analysis are particularly strong in the chemical processing, refining, oil & gas and pulp & paper industries. Failure mechanisms evaluated usually include:

- general-, localized-, intergranular-, weld- and microbiological corrosion

- stress corrosion- & hydrogen sulfide-cracking
- fatigue & corrosion fatigue
- fretting & wear
- erosion
- overload
- brittle fracture
- hydrogen embrittlement
- oxidation, sulfidation & carburization
- The identification of the factors associated with the forms of corrosion can guide failure investigators.

For fracture analysis, both the microstructure and fracture surface are analyzed. The fracture surface topography revealed at high magnification indicates:

- type of stress (tensile, shear, torsional)
- mode of fracture (ductile, brittle, fatigue, overload)
- direction of fracture propagation
- area and mechanism of fracture initiation
- manufacturing or repair related factors contributing to the failure
- other factors related to cause of failure

Background

These kinds of investigation engineering are the process of gathering and analyzing samples to determine the root cause (source) of the failure, inclusion and/or corrosion and the severity of thereof. BEAM specializes in failure, inclusion and/or corrosion investigation and the analytical techniques used to identify failure and corrosion mechanisms.

Corrosion, an electrochemical reaction which is a common catastrophic failure mode for metallic materials, usually leaves behind a corrosion pattern and product which can be analyzed with various microscopy techniques. These techniques can include but are not limited to optical microscopy, SEM coupled with EDS, ICP and CT Scanning. Common corrosion patterns include pitting, crevice corrosion, galvanic corrosion, and environmentally induced cracking (EIC). EIC can be stress-corrosion cracking (SCC), corrosion fatigue cracking (CFC), or hydrogen-induced cracking (HIC). Corrosion can cause buildings and bridges to collapse, oil pipelines to break, chemical plants leak, bathrooms floods, etc. Corroded electrical contacts can cause fires and other problems and corroded medical implants may lead to blood poisoning.

Inclusions are characteristics that occur inside or on the surface of products that cause the product or material to not pass the QC process or fail. These inclusions make the product less brilliant and cause an undesired outcome. In the power generation industry, deposits on turbine blades and boilers can impair operation and increase maintenance costs. The chemical composition of the layers of deposits may need to be identified to assist with determining the possible root cause. During failure analysis on large plant or equipment, small pieces of material found during the investigation may need to be identified, again to assist with determining the failure mechanism or origin. These kinds of materials can be analyzed using SEM-EDS, ICP-MS and Raman Spectroscopy.

Approaches

Typically, at BEAM the failure/corrosion product will first be identified and discussed in full with the client. It is highly important, for a complete and thorough analysis, that all possible information about the manufacturing or environmental conditions to which the samples were exposed are shared with the team. With corrosion studies the areas of interest are often at any penetrations or crack surfaces. Cracked surfaces and cracked edges can yield information as to the failure/corrosion mechanism and are examined with microscopy.

BEAM will perform all the sample preparation (metallographic) beforehand to assist with the designed analytical procedures chosen to aid in determining the mechanism of failure by analyzing the penetrations or other corrosion surface features. The sample preparation can include cleaning, epoxy mounting, sectioning, grinding and polishing. At BEAM we have found that the sample preparation is of high importance and for high quality data the sample preparation needs to be done to the highest standard.