

Blue Etch Anodize

NDT Inspection Process Tech Brief

Process Overview

Blue Etch Anodizing (BEA) is a highly sensitive nondestructive testing (NDT) technique to detect surface discontinuities such as laps, cracks, material segregations, heat-treating imperfections, and abnormalities caused by machining. Under normal conditions, surface defects as small as .015" can be reliably detected.

The BEA process involves a slight removal of base material (on the order of .00008" thick) via acid etch to expose grains. Next, a similar thickness of material is deposited via electrochemical oxidizing (anodize) to result in the proper color (typically light blue) for inspection. The resulting BEA surface condition is typically left on, however, it can also be back stripped when required to return the surface to grayish color.



Developed BEA surface showing Titanium grain size and grain flow on a critical rotating aircraft component

BEA is specifically used to detect discontinuities in Titanium materials such as those involved in the manufacture of critical rotating parts for the aircraft and power generation industries.

At Metals Testing Company (MTC), we have a complete in-house capability of equipment, chemicals, procedures, qualified personnel, waste treatment, environmental related permits, and industry certifications to accomplish high quality BEA related inspections. **With regard to aircraft engine manufacturers, MTC is one of the few approved independent laboratories in the world that is certified to perform BEA inspections.**

The BEA process consists of the following steps:

- Receipt/Traveler Documentation
- Alkaline Based Cleaning
- Pre-anodize Acid Etch
- Anodize (Voltage in TSP Solution)
- "Develop" via Post-anodize Acid Etch (Back Etch)
- Visual Inspection (magnification if required)
- Evaluation & Disposition of Any Indications
- C-of-C Quality Documentation
- Pack & Ship

For small and medium quantities of parts, the entire BEA process is typically done within a 24-hour turn around.

Typical Applications

BEA inspections are applicable to all Titanium materials, however are most commonly used for Ti 6-4 and Ti 17 in aircraft components. Parts typically inspected include spools, disks, hubs, shafts, vanes, blades, blade locks, and engine mounts (i.e., any flight critical parts made of Titanium).

Hard Alpha & High Aluminum Discontinuities

One of the most critical applications of BEA is to detect material segregations known as "Hard Alpha Inclusions" (HAI), and/or High Aluminum Defects (HAD's). Detecting these discontinuities came to the forefront of the NDT industry following a disk failure related crash in 1989. Hard Alpha is an area in the material that has been contaminated and altered by Oxygen and Nitrogen during its formation. HAD is an area of higher concentration of Aluminum. Under BEA, HAI's and HAD's are both observed as dark discontinuities (i.e., their strong bonds tend to attract anodize process related electrons). Such strength, however, also makes HAI & HAD areas brittle, thereby being NDT Indications of concern.



Ground Based Turbine Blades after BEA inspection

Applicable Codes & Standards

MTC's Blue Etch Anodize process complies with and has been approved for the following requirements: General Electric's P3TF25, Pratt & Whitney's EIM Code 3, and Rolls Royce's RPS 675 as well as SAE's AMS 2642A and FAA requirements.

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