



FRACTOGRAPHY REPORT

GENERAL ANALYSIS OF SUPPLIED MATERIAL

TO: Perfect Point, Inc.
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PROJECT NO.: 6032-106551-2
REVISION NO.: 0
DATE: June 11, 2021
AUTHORIZATION: P1073-SBIR2

PROJECT: Per customer's request, Metcut Research Inc. performed the following:

1. Fractography of both fracture faces via SEM method.
2. General assessment of fracture face.
3. Location and size of each initiation site.
4. Number of initiation sites.
5. Chemical variance at initiation site(s) if inclusion observed.
6. Identification of any anomalies (if they exist).

Material: AL7075-T651
Sample No.: NB 9 and ECNR 8
Specimen Size: 106551-1 Rev. 2
Number of samples: 2

SUMMARY:

Please find the enclosed images acquired from material submitted to Metcut Research Inc. Images were acquired in Backscattered Electron Imaging (BEI) mode and Secondary Electron Imaging (SEI) mode to clearly show the initiation site(s). Additional questions or concerns can be discussed at the customer's convenience.

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I. INTRODUCTION:

As requested by customer and as presented in the following review, an assessment of material from the supplied samples has been completed. Standard laboratory techniques were used for each requested task. This includes, but was not limited to, SEM review of fracture faces of supplied specimens. Metcut's latest procedural revisions applied to all tasks performed. All data has been inserted into the report for customer review.

II. DATA AND CONCLUSION:

The first task was to remove and clean each sample prior to placement in SEM chamber. Fracture surfaces on both sides of hole were then reviewed where initiation occurred. All observations about the specimen(s) are outlined in the figures below including number of initiation sites, location and size. An EDS detector was used to provide qualitative analysis of any elemental variation at the initiation if applicable.

SEM micrographs of the sample(s) are presented in the following figures. Low magnification and intermediate magnification images are presented followed by higher magnification images where the initiation site has been identified. Sample orientation is retained with each image unless noted.

All final interpretations are left to customer. Metcut will, at customer's discretion, discuss in more detail any of the observations that have been made. Please feel free to contact us at your convenience with additional comments or questions.

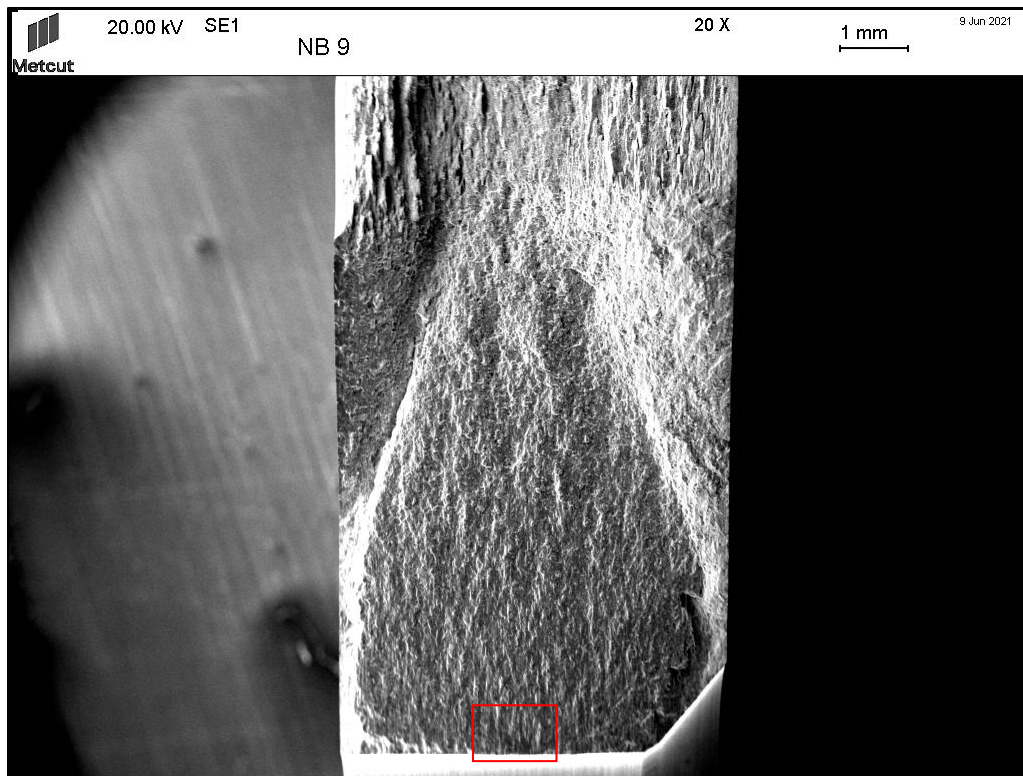


Figure 1. Fracture face of sample NB 9, Site 1 is shown at low magnification, (SEI mode, 0° tilt). The red box identifies the initiation site.

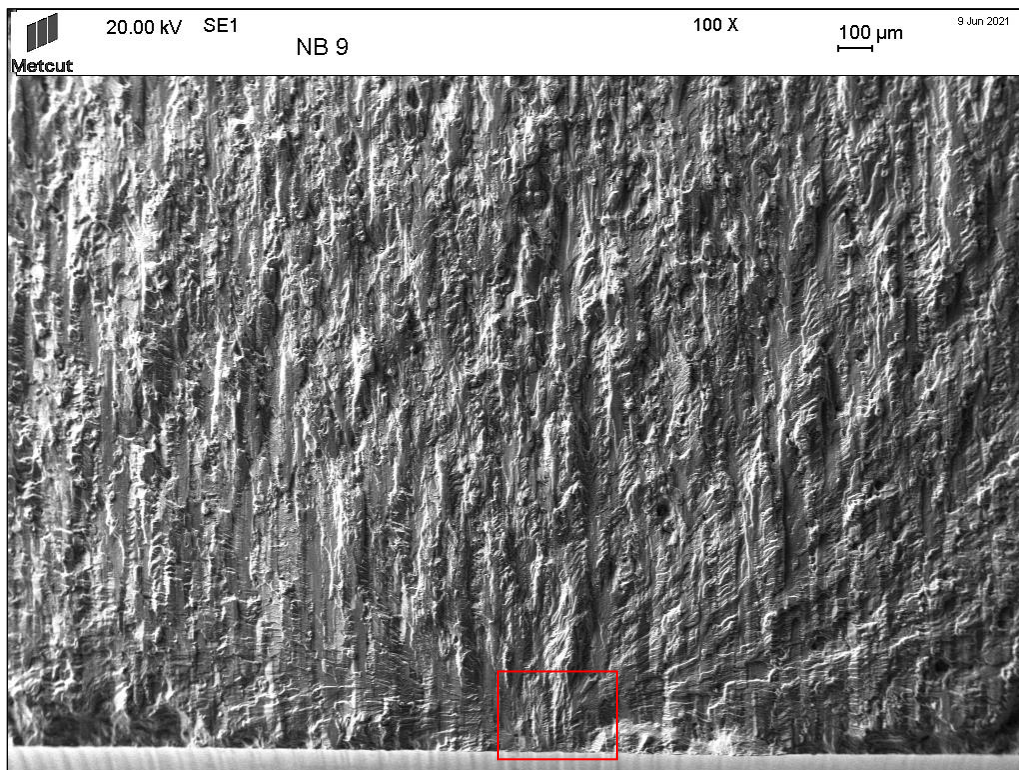


Figure 2. Fracture face of sample NB 9, Site 1 is viewed at intermediate magnification, (SEI mode, 0° tilt). A red box identifies the initiation site.

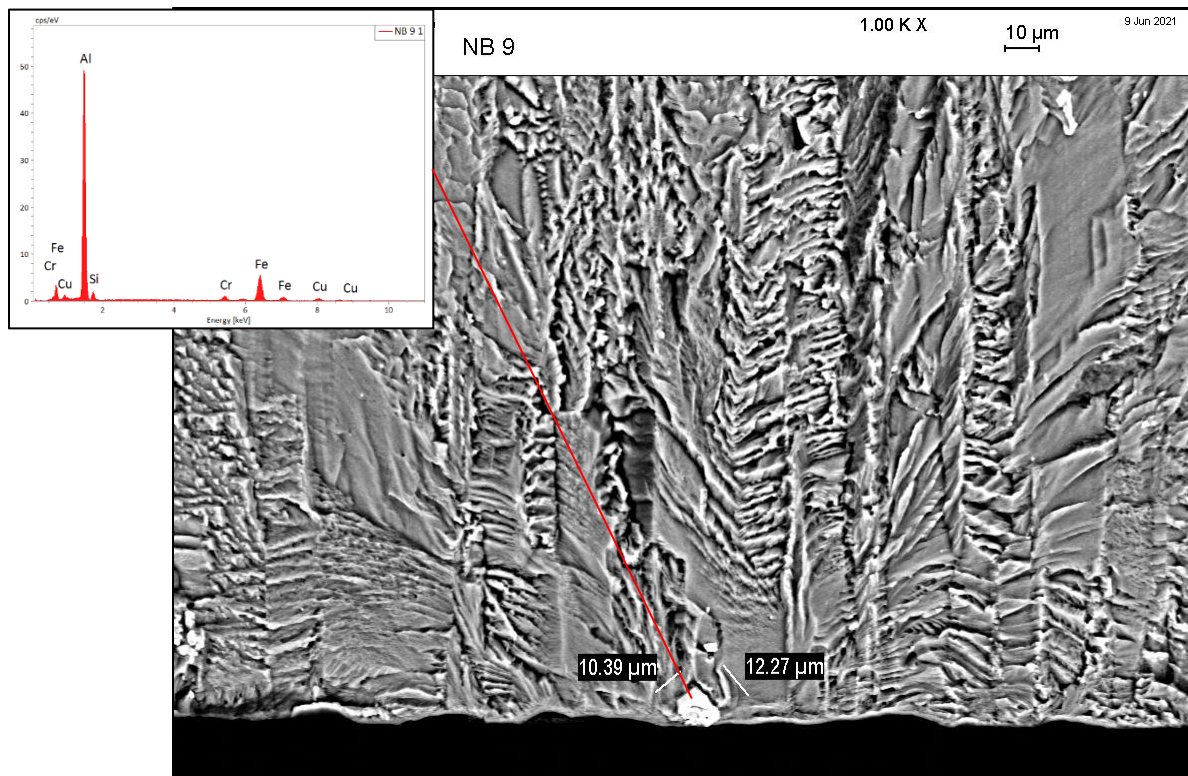


Figure 3. Initiation site for specimen NB 9, Site 1 is seen at higher magnification, (BEI mode, 0° tilt). Inclusion at the surface measuring 10.4 μm x 12.3 μm was observed at the initiation site. Inclusion contains mostly Aluminum with concentrations of Iron, Copper, Silicon and Chromium.

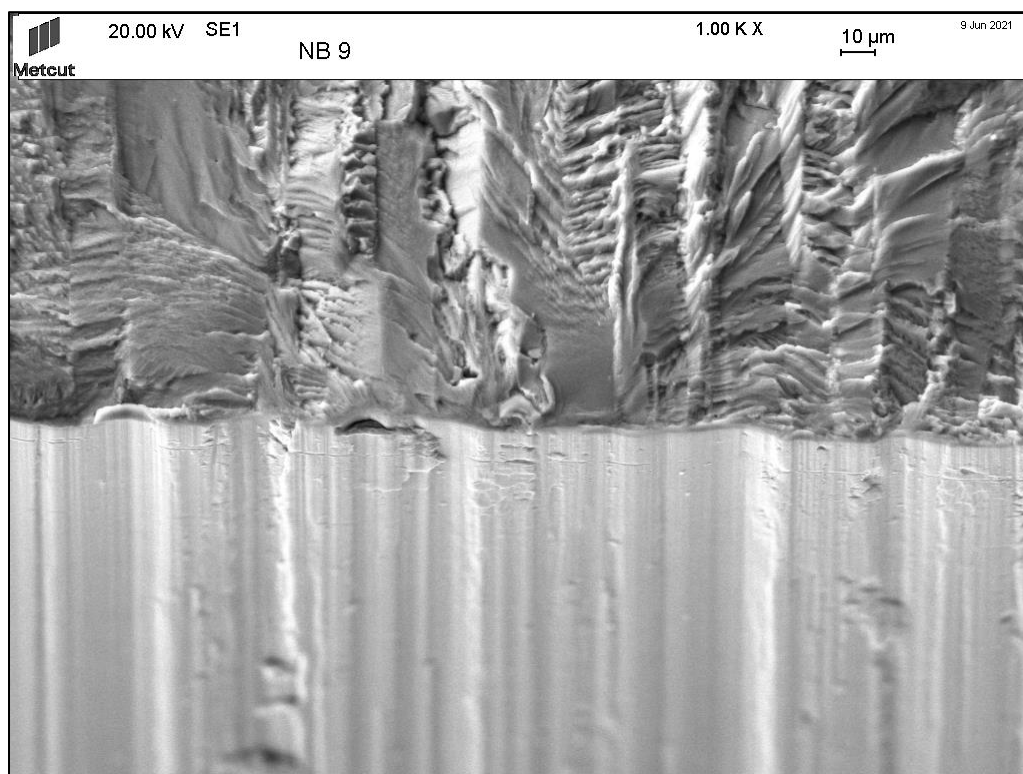


Figure 4. Initiation site for specimen NB 9, Site 1 is seen at higher magnification, (SEI mode, 15° tilt).

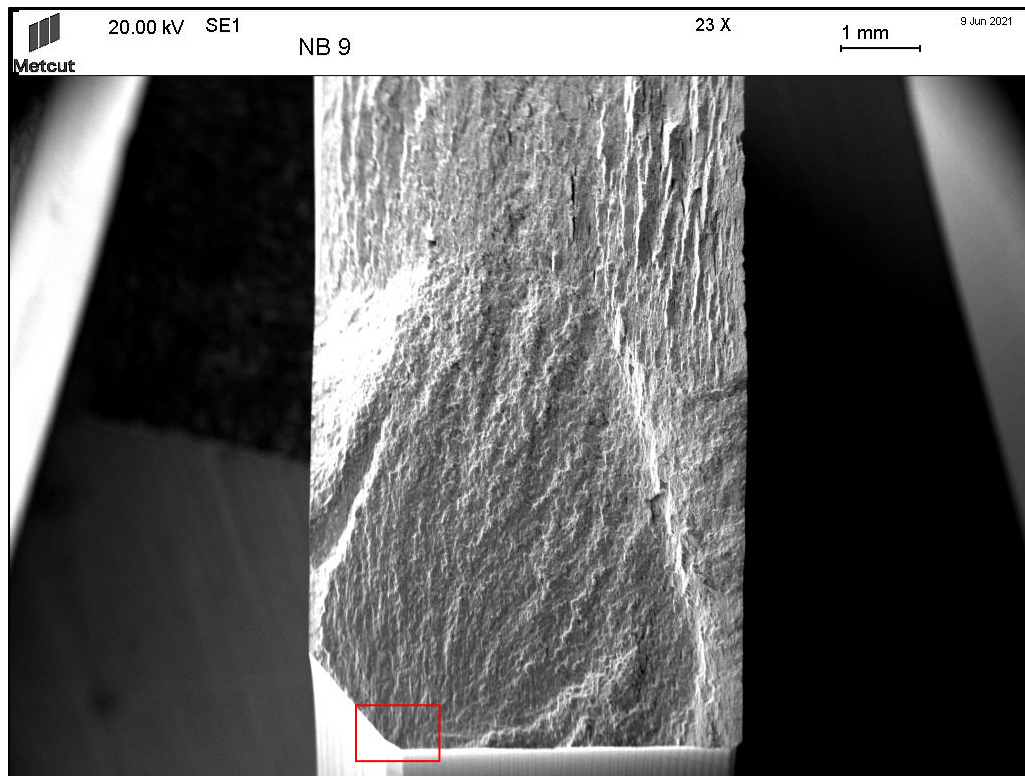


Figure 5. Fracture face of sample NB 9, Site 2 is shown at low magnification, (SEI mode, 0° tilt). The red box identifies the initiation site.

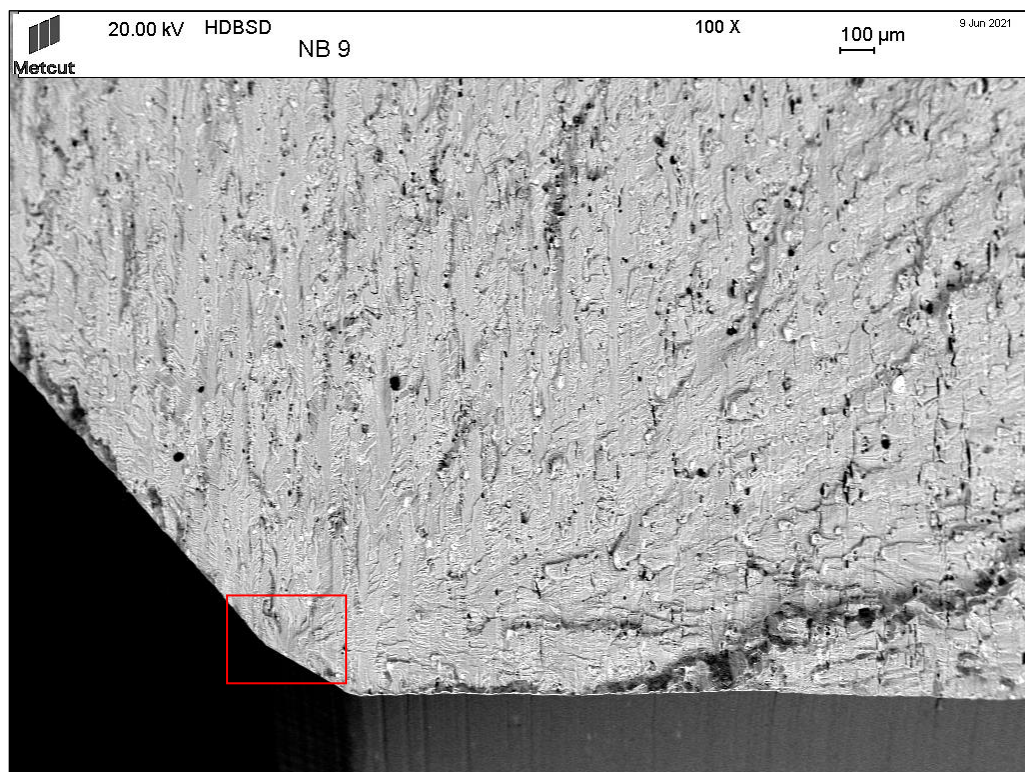


Figure 6. Fracture face of sample NB 9, Site 2 is viewed at intermediate magnification, (SEI mode, 0° tilt). A red box identifies the initiation site.

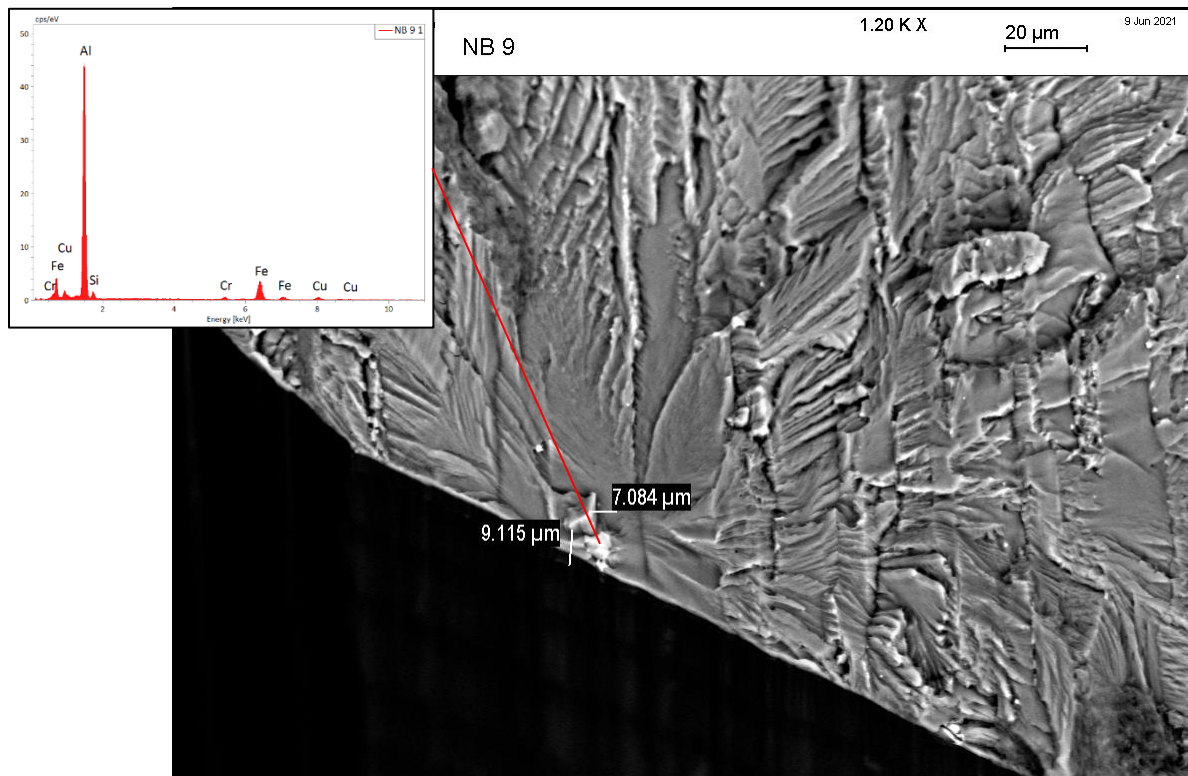


Figure 7. Initiation site for specimen NB 9, Site 2 is seen at higher magnification, (BEI mode, 0° tilt). Inclusion at the surface measuring 7.1 µm x 9.1 µm was observed at the initiation site. Inclusion contains mostly Aluminum with concentrations of Iron, Copper, Silicon and Chromium.

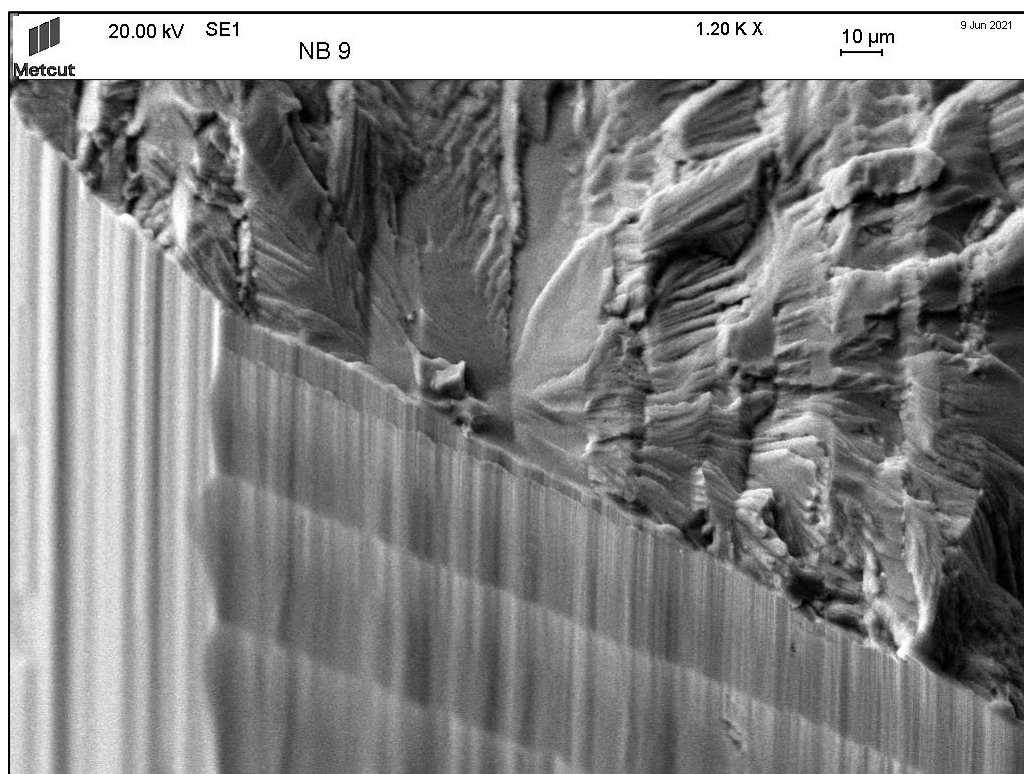


Figure 8. Initiation site for specimen NB 9, Site 2 is seen at higher magnification, (SEI mode, 15° tilt).

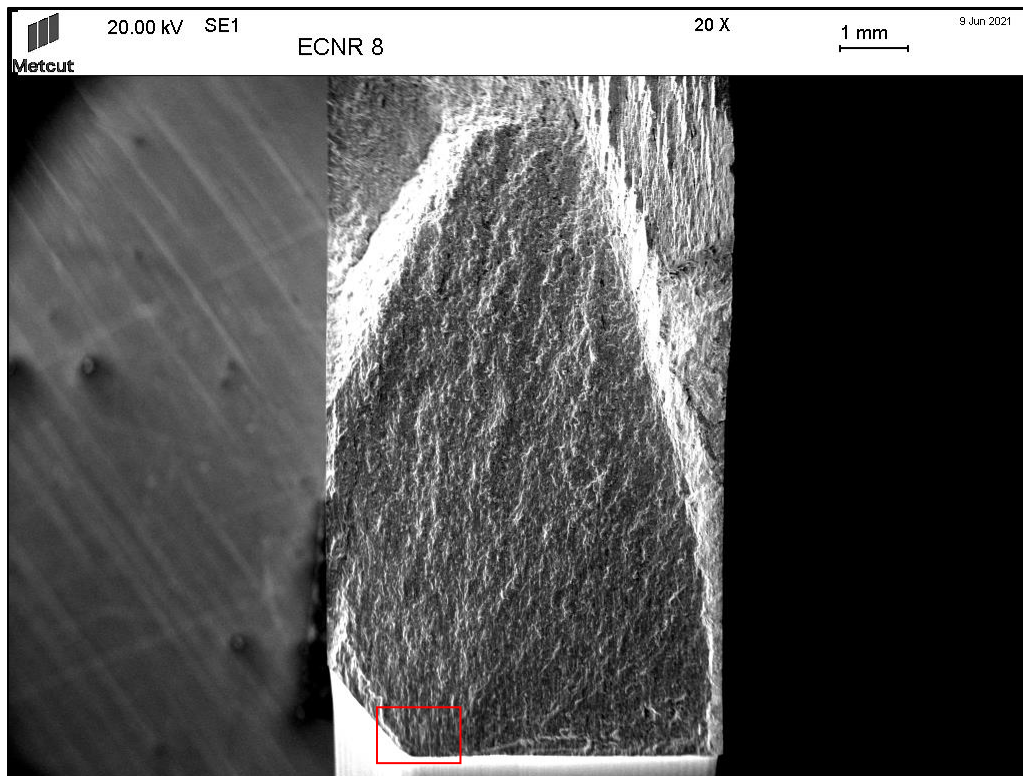


Figure 9. Fracture face of sample ECNR 8, Site 1 is shown at low magnification, (SEI mode, 0° tilt). The red box identifies the initiation site.

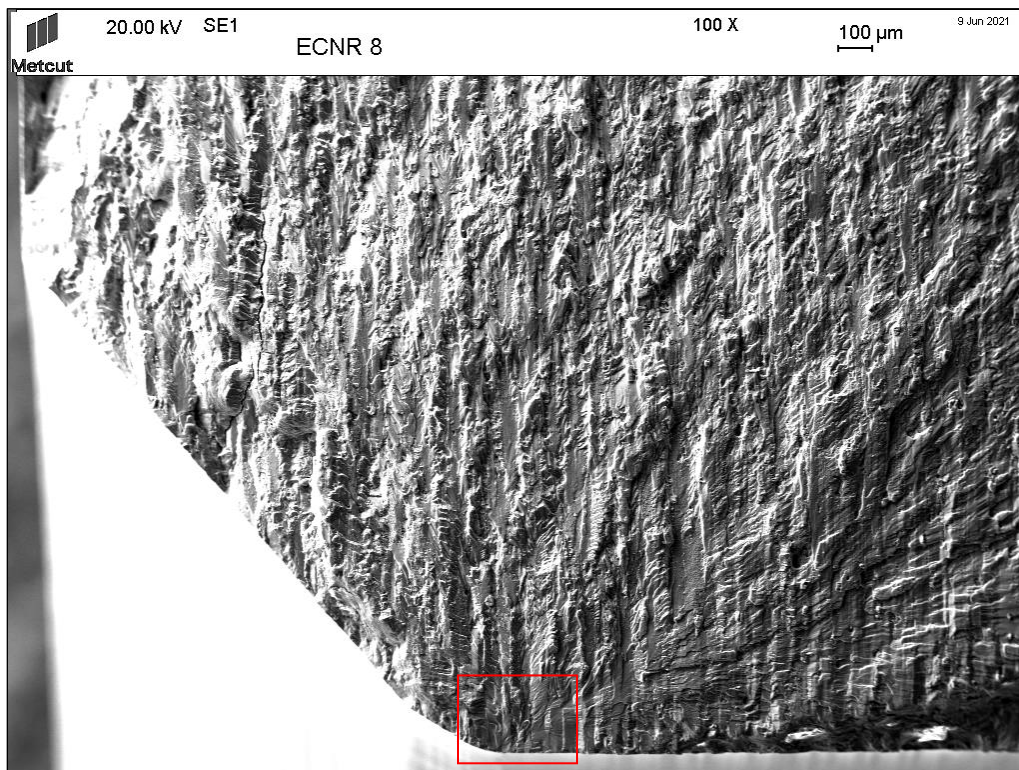


Figure 10. Fracture face of sample ECNR 8, Site 1 is viewed at intermediate magnification, (SEI mode, 0° tilt). A red box identifies the initiation site.

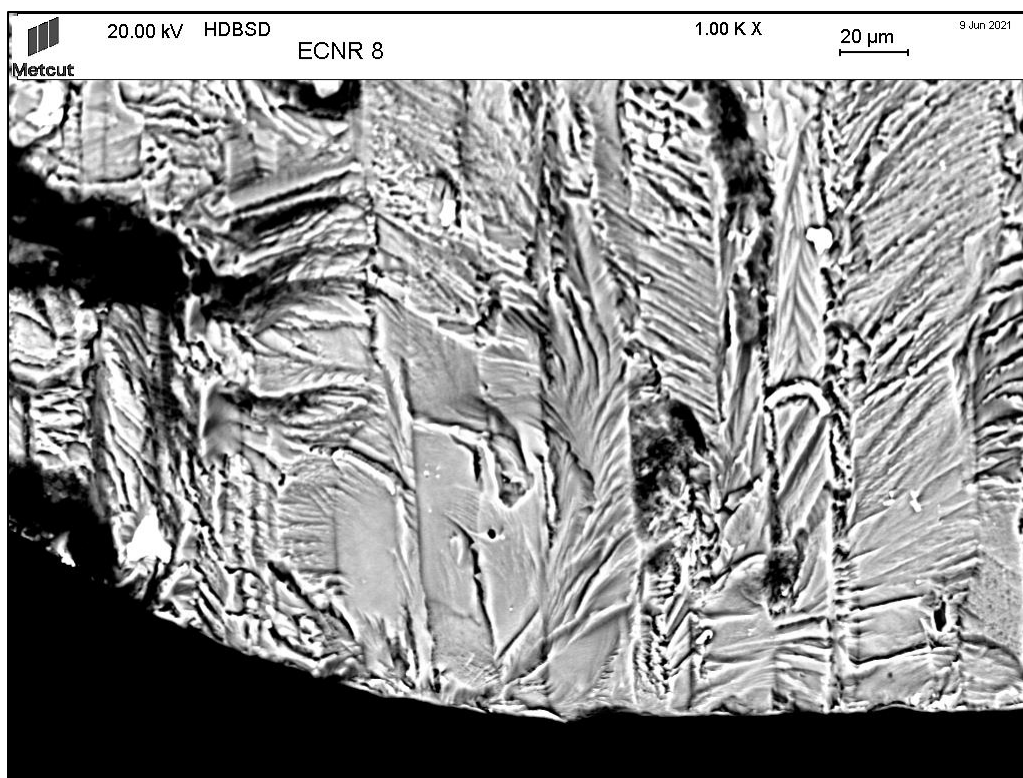


Figure 11. Initiation site for specimen ECNR 8, Site 1 is seen at higher magnification, (BEI mode, 0° tilt). Grain failure at the surface was observed at the initiation site.

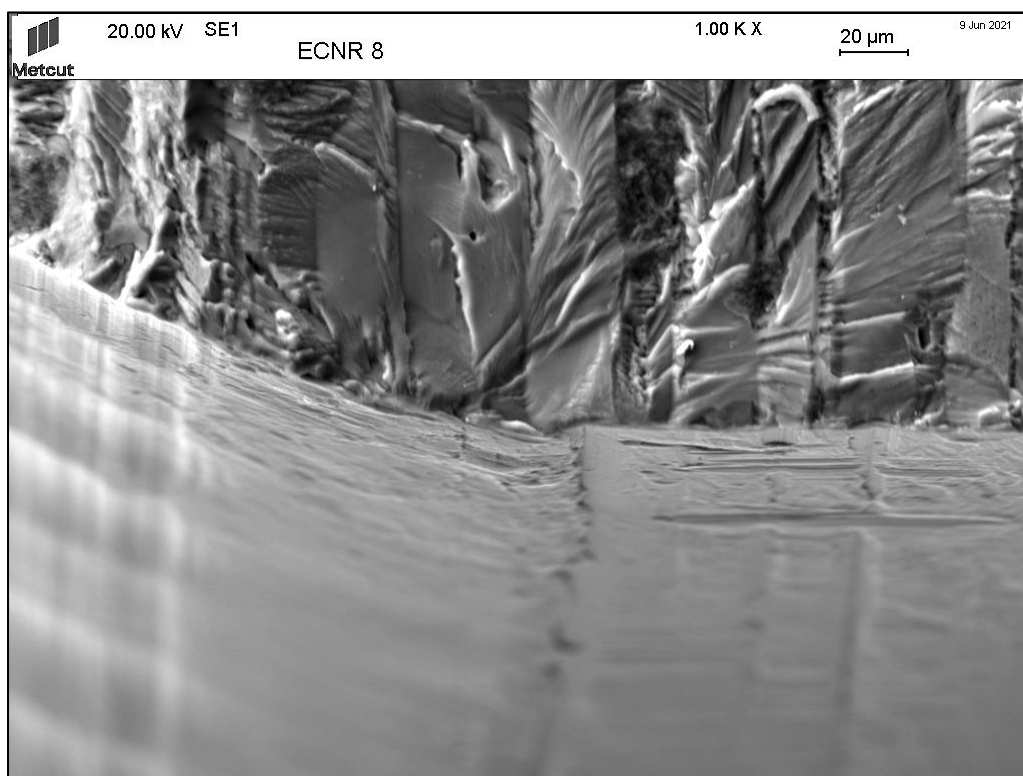


Figure 12. Initiation site for specimen ECNR 8, Site 1 is seen at higher magnification, (SEI mode, 15° tilt).

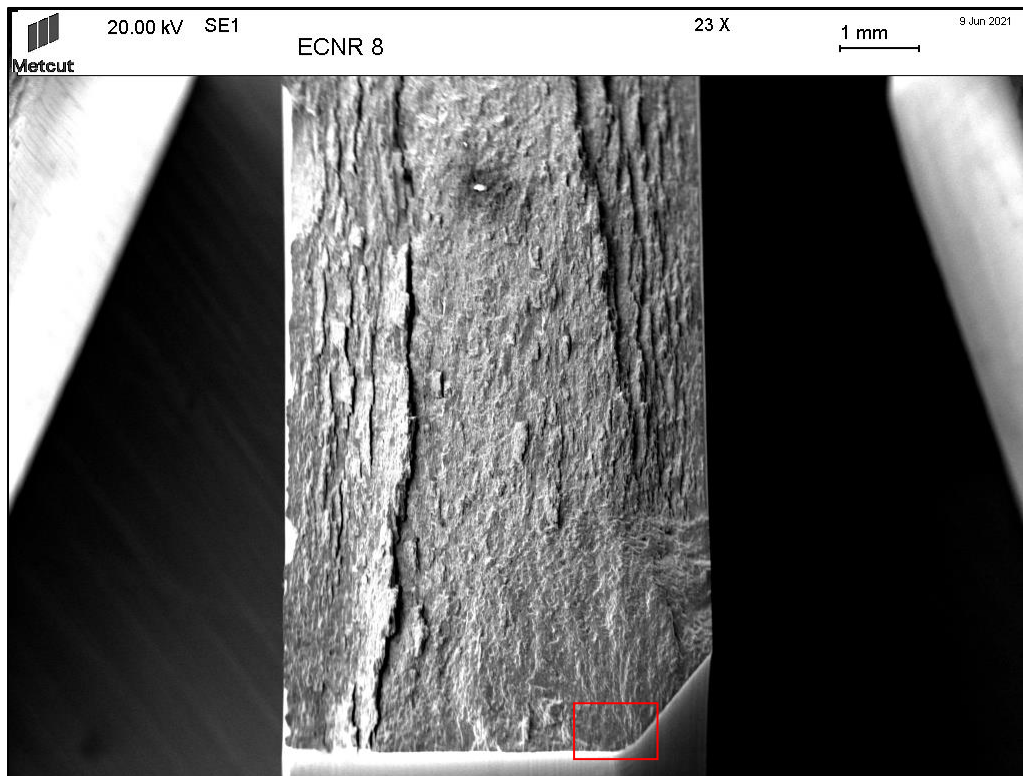


Figure 13. Fracture face of sample ECNR 8, Site 2 is shown at low magnification, (SEI mode, 0° tilt). The red box identifies the initiation site.

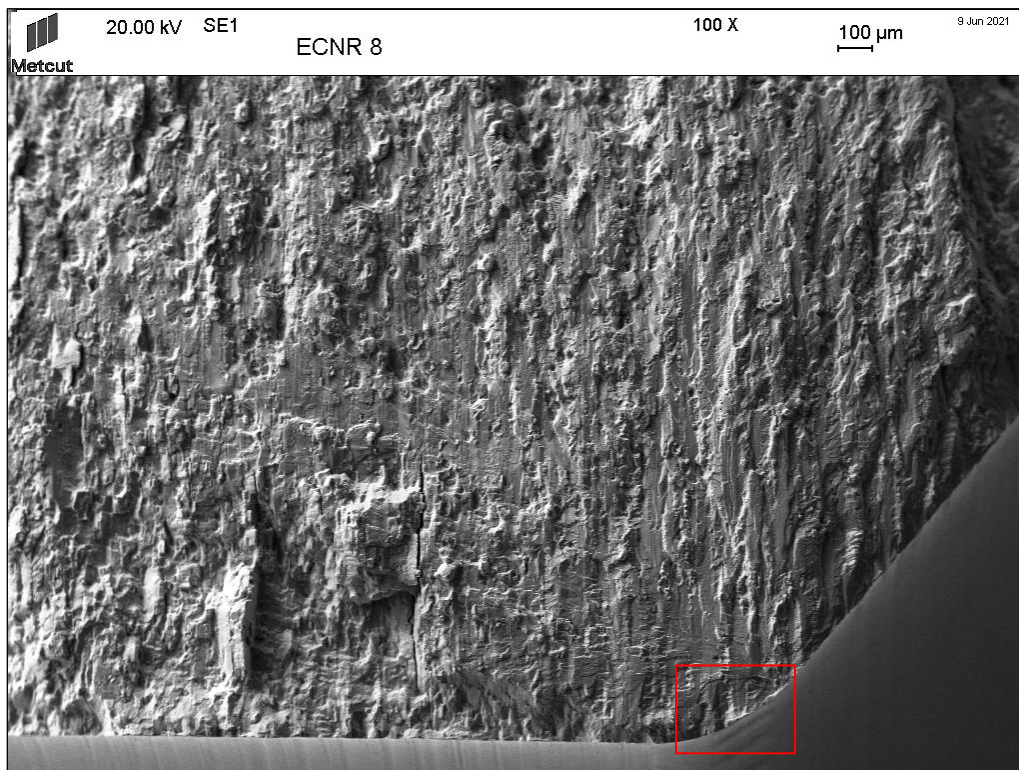


Figure 14. Fracture face of sample ECNR 8, Site 2 is viewed at intermediate magnification, (SEI mode, 0° tilt). A red box identifies the initiation site.

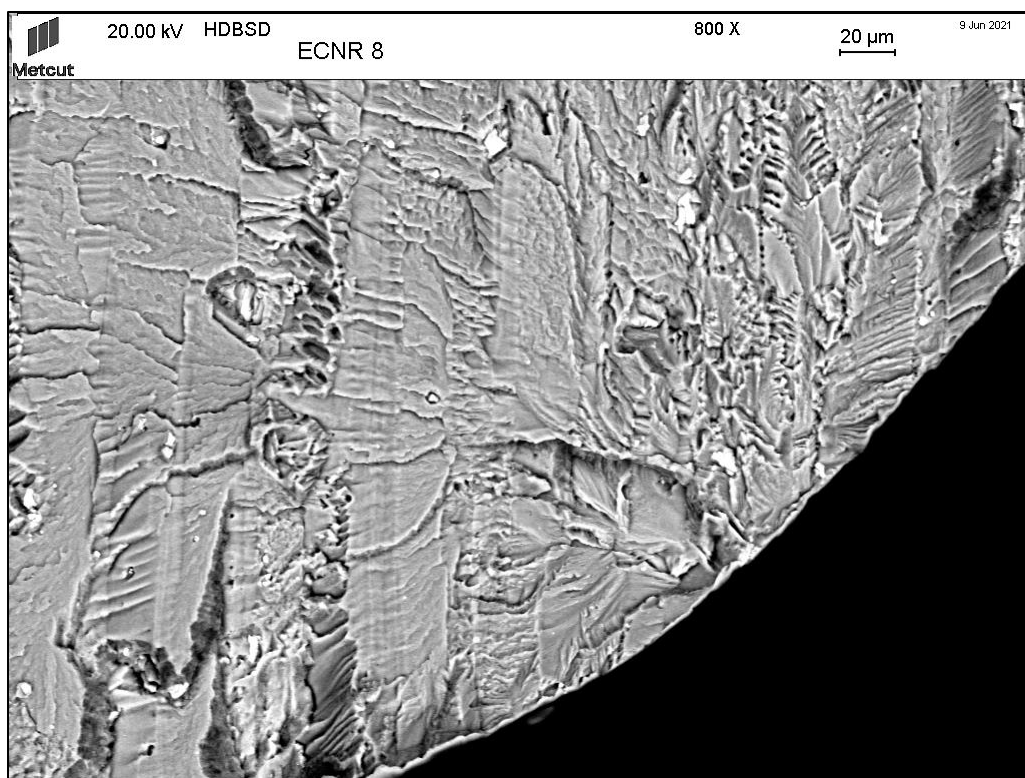


Figure 15. Initiation site for specimen ECNR 8, Site 2 is seen at higher magnification, (BEI mode, 0° tilt). Grain failure at the surface was observed at the initiation site.

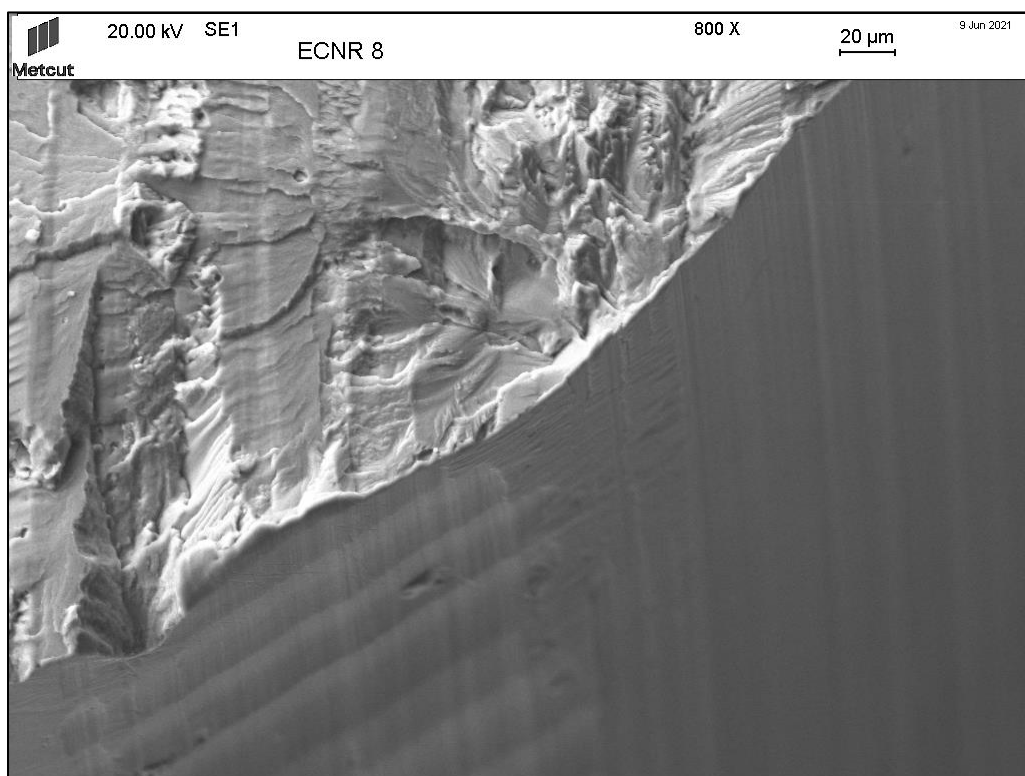


Figure 16. Initiation site for specimen ECNR 8, Site 2 is seen at higher magnification, (SEI mode, 15° tilt).