



LABORATORY REPORT

TO: Perfect Point, Inc.
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PROJECT NO.: 6032-106782-1
REVISION NO.: 1
DATE: June 25, 2021
Original Date: June 21, 2021
AUTHORIZATION: P1367-SBIR

PROJECT: Per customer's request, Metcut Research Inc. sectioned, mounted, polished, etched, and analyzed the supplied specimens, see Figure 1.

1. Metallographic evaluation of EDM cut surfaces.

Sample IDs:	See Table 1
Material:	T7075 Aluminum
Number of samples:	9
MRI Mount No.:	See Table 1
Etchant:	Keller's

Revision 1: Per customer's request, Table I, MRI Mount# 83951 and 83952 Maximum Recast Thickness changed to None observed. Figures 4 and 6 replaced to show no recast measurement.

SUMMARY:

Please find enclosed the data acquired from the material submitted to Metcut Research Inc. The technique employed for analysis was standard metallography. These tasks were carried out via Metcut's latest revision of needed procedures with references to all applicable ASTM specifications and customer's supplied specifications. If you have any further questions or would like to discuss the results, please feel free to contact us at your leisure.

A handwritten signature in black ink, appearing to read "Christopher Starr".

Christopher S. Starr, Eng. Assistant II
Materials Analysis Laboratory, and
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A handwritten signature in black ink, appearing to read "Thomas B. McCall".

Thomas B McCall, Eng. Assistant I
Materials Analysis Laboratory, and
Central Coatings Laboratory

I. INTRODUCTION:

Per customer's request, a review of the supplied material was performed. The specified tests were completed utilizing standard laboratory techniques. These tests include, but are not limited to, polishing and etching (Keller's) specimen to analyze the EDM cut area for recast layer, HAZ and microcracking with special attention to the chamfer area of the EDM cut. Optical microscopy was used for all reported measurements and analysis, and reference images are shown below. Table I gives all test results. Metcut's latest procedure revisions applied to all tasks completed. All data has been inserted into the report for customer review.

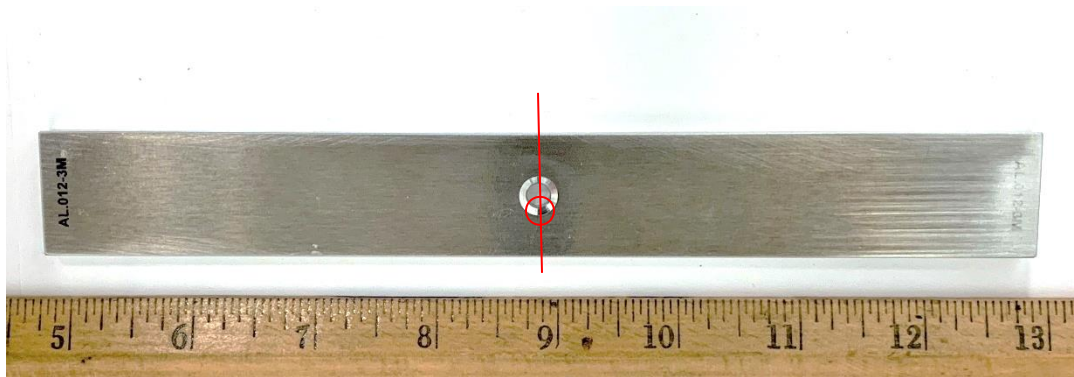
II. DATA AND CONCLUSION:

The supplied samples were sectioned, mounted, polished, and etched in effort to reveal the microstructure of the full EDM cut.

Since Metcut was not privy to all background data, design requirements or otherwise, 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.

TABLE I. Customer IDs and mount numbers with test results for the received aluminum samples.

MRI Mount#	Customer Sample ID's	Deepest Crack Observed (inches)	Maximum Recast Thickness (inches)	HAZ Thickness (inches)
83950	AL.012 1M	None observed	0.0002	None observed
83951	AL.012 2M	None observed	None observed	None observed
83952	AL.012 3M	None observed	None observed	None observed
83953	AL.015 1M	0.002	0.003	0.004
83954	AL.015 2M	0.004	0.003	0.005
83955	AL.015 3M	0.002	0.003	0.005
83956	AL.021 1M	0.003	0.003	0.004
83957	AL.021 2M	0.002	0.003	0.004
83958	AL.021 3M	0.004	0.005	0.008

**FIGURE 1.** Representative example of EDM samples received for analysis. Red line shows sectioning location. Red circle shows area of interest shown in photomicrographs.

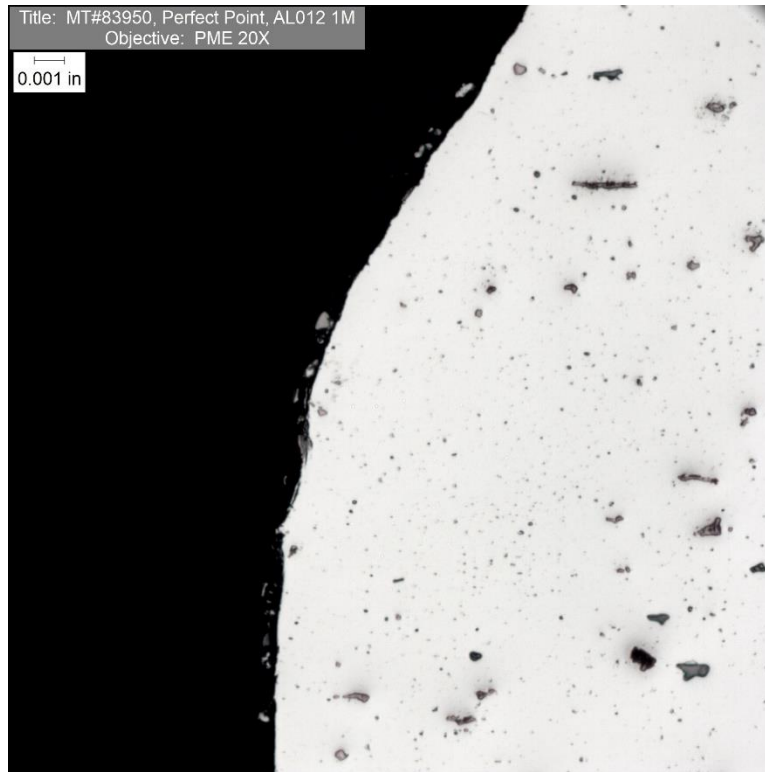


FIGURE 2. MRI Mount No.: 83950. Typical microstructure of the supplied sample AL.012 1M is presented in the unetched condition showing the full EDM cut area. No cracking observed. 200X magnification.

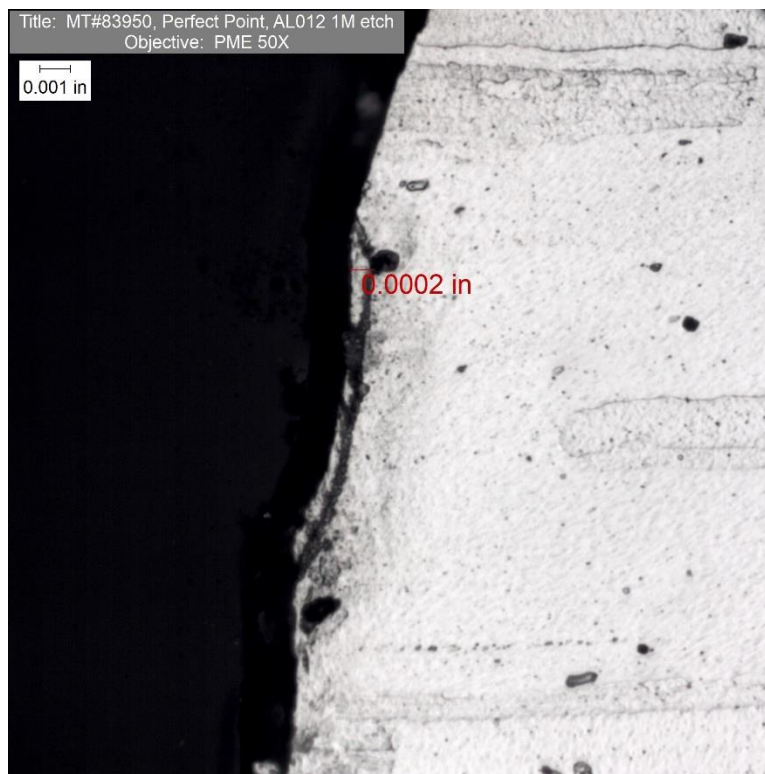


FIGURE 3. MRI Mount No.: 83950. Microstructure of the supplied sample AL.012 1M is presented in the etched condition showing EDM cut with thickest recast layer observed, 500X magnification, Keller's etch.

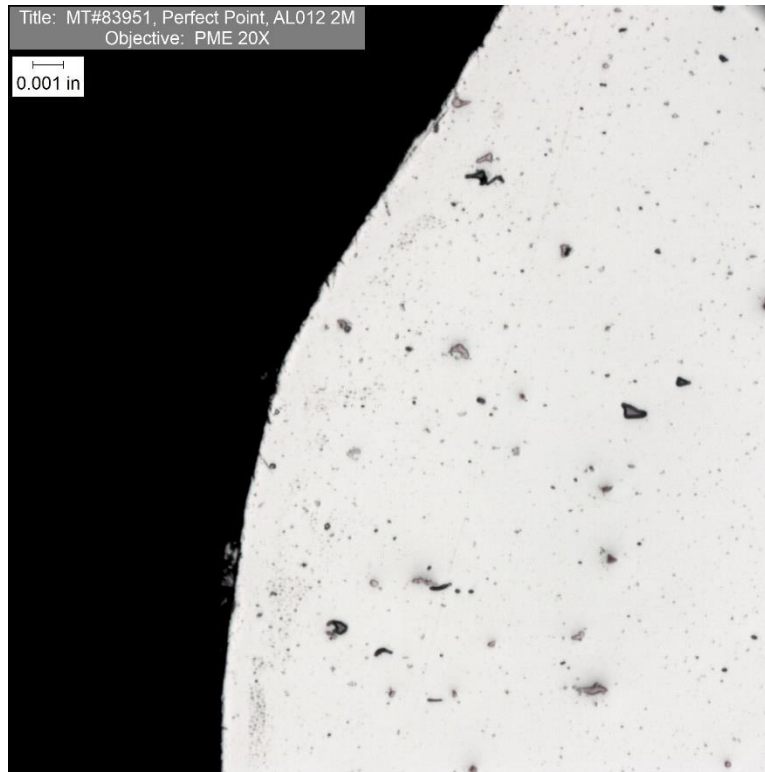


FIGURE 4. MRI Mount No.: 83951. Typical microstructure of the supplied sample AL.012 2M is presented in the unetched condition showing the full EDM cut area. No cracking observed. 200X magnification.

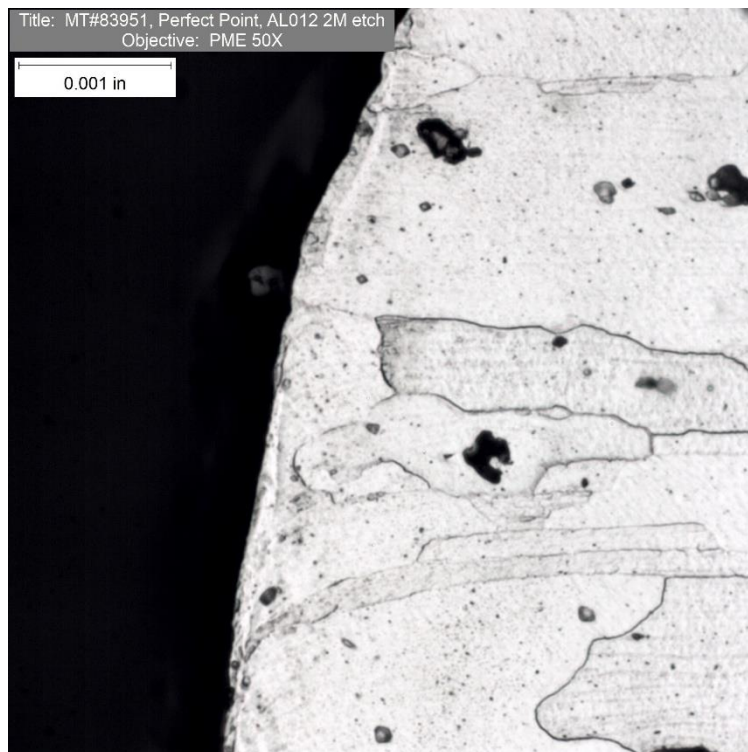


FIGURE 5. MRI Mount No.: 83951. Microstructure of the supplied sample AL.012 2M is presented in the etched condition showing EDM cut. No recast layer was observed. 500X magnification, Keller's etch.

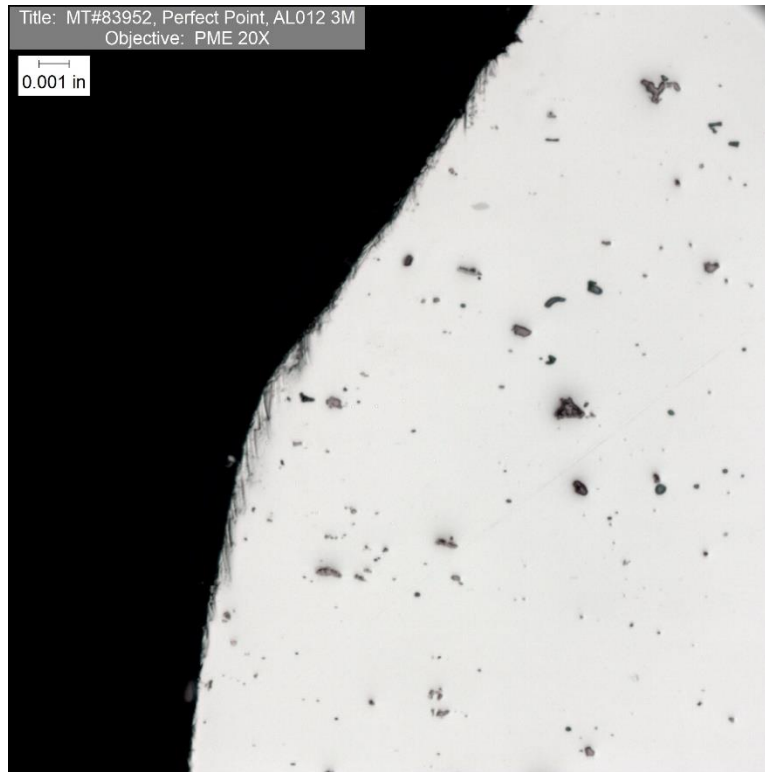


FIGURE 6. MRI Mount No.: 83952. Typical microstructure of the supplied sample AL.012 3M is presented in the unetched condition showing the full EDM cut area. No cracking observed. 200X magnification.

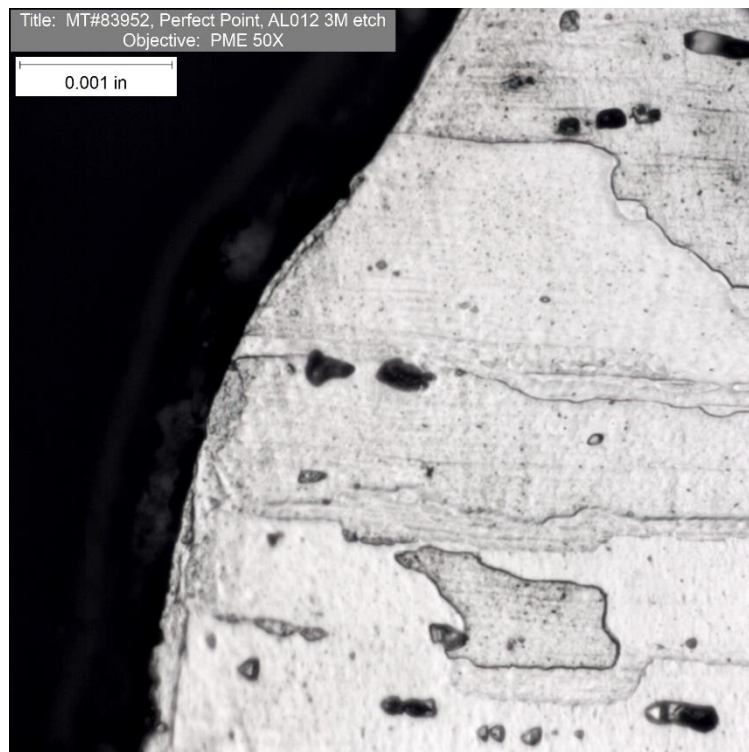


FIGURE 7. MRI Mount No.: 83952. Microstructure of the supplied sample AL.012 3M is presented in the etched condition showing EDM cut. No recast layer was observed. 500X magnification, Keller's etch.

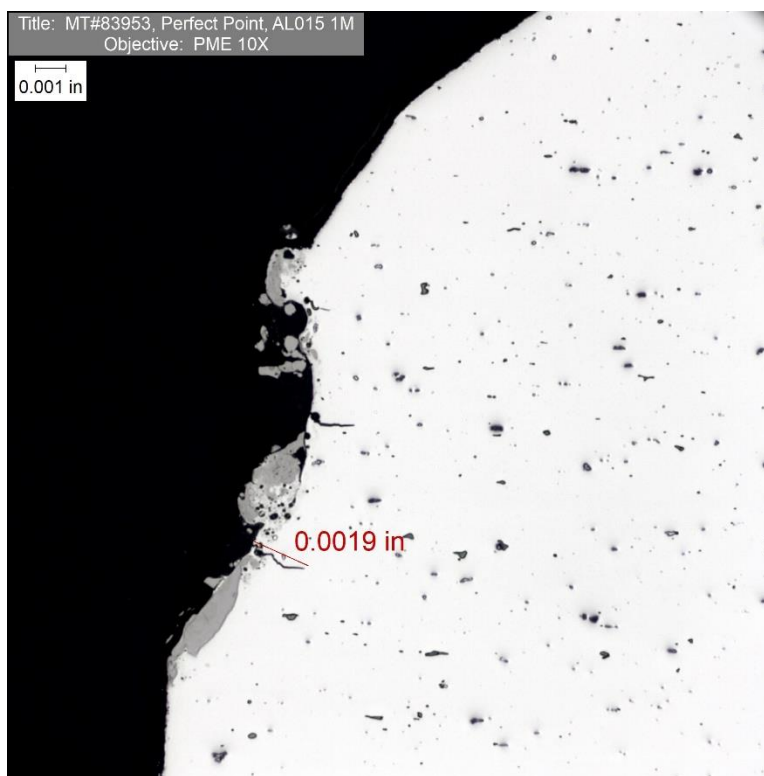


FIGURE 8. MRI Mount No.: 83953. Typical microstructure of the supplied sample AL.015 1M is presented in the unetched condition showing the full EDM cut area. Cracking was observed. 100X magnification.

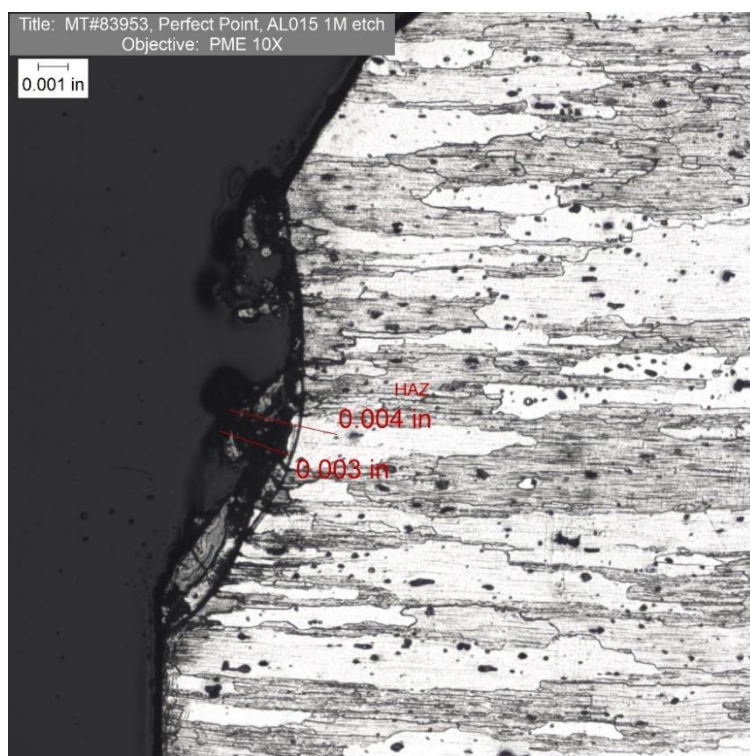


FIGURE 9. MRI Mount No.: 83953. Microstructure of the supplied sample AL.015 1M is presented in the etched condition showing EDM cut with thickest recast layer and HAZ observed, 100X magnification, Keller's etch.

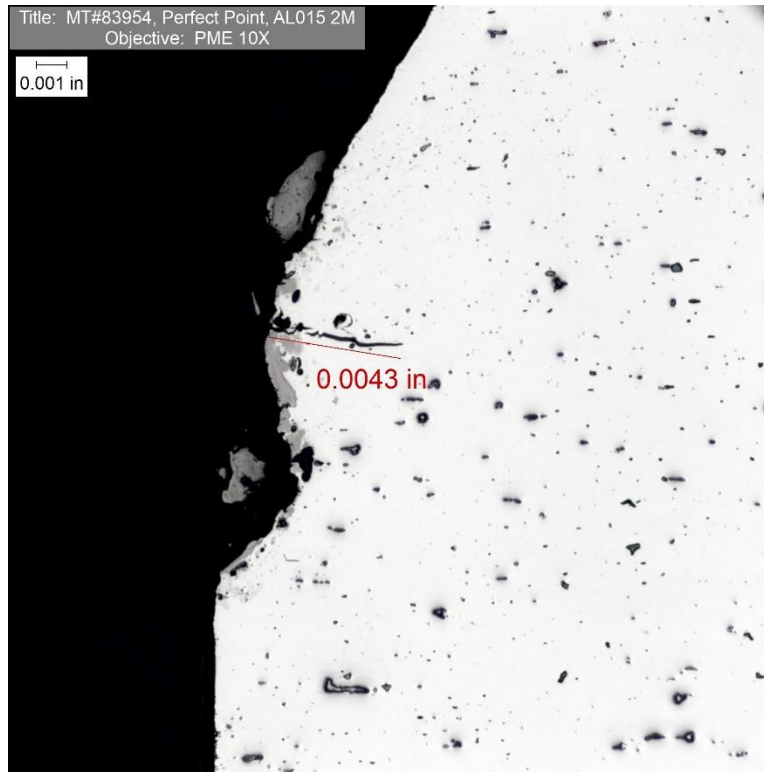


FIGURE 10. MRI Mount No.: 83954. Typical microstructure of the supplied sample AL.015 2M is presented in the unetched condition showing the full EDM cut area. Cracking was observed. 100X magnification.

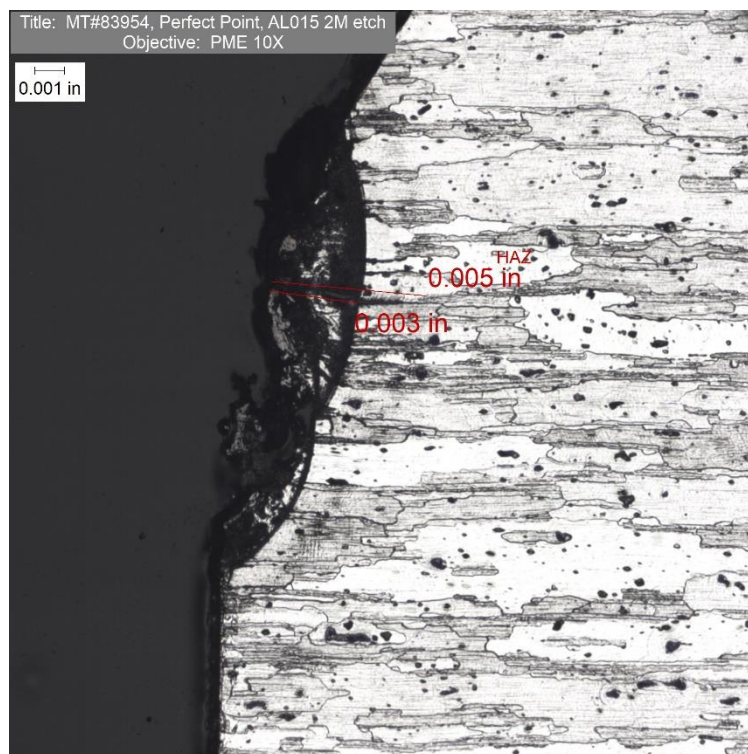


FIGURE 11. MRI Mount No.: 83954. Microstructure of the supplied sample AL.015 2M is presented in the etched condition showing EDM cut with thickest recast layer and HAZ observed, 100X magnification, Keller's etch.

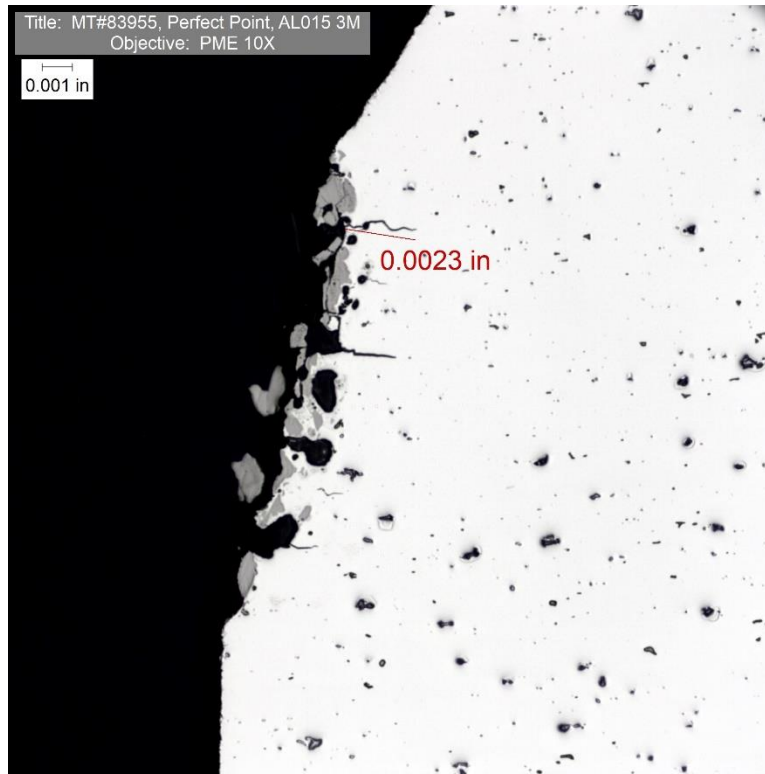


FIGURE 12. MRI Mount No.: 83955. Typical microstructure of the supplied sample AL.015 3M is presented in the unetched condition showing the full EDM cut area. Cracking was observed. 100X magnification.

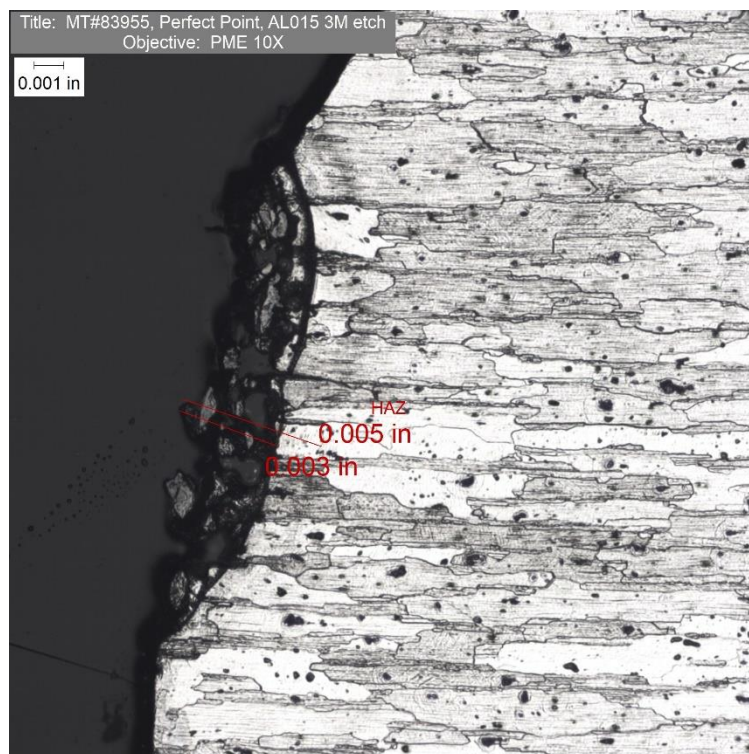


FIGURE 13. MRI Mount No.: 83955. Microstructure of the supplied sample AL.015 3M is presented in the etched condition showing EDM cut with thickest recast layer and HAZ observed, 100X magnification, Keller's etch.

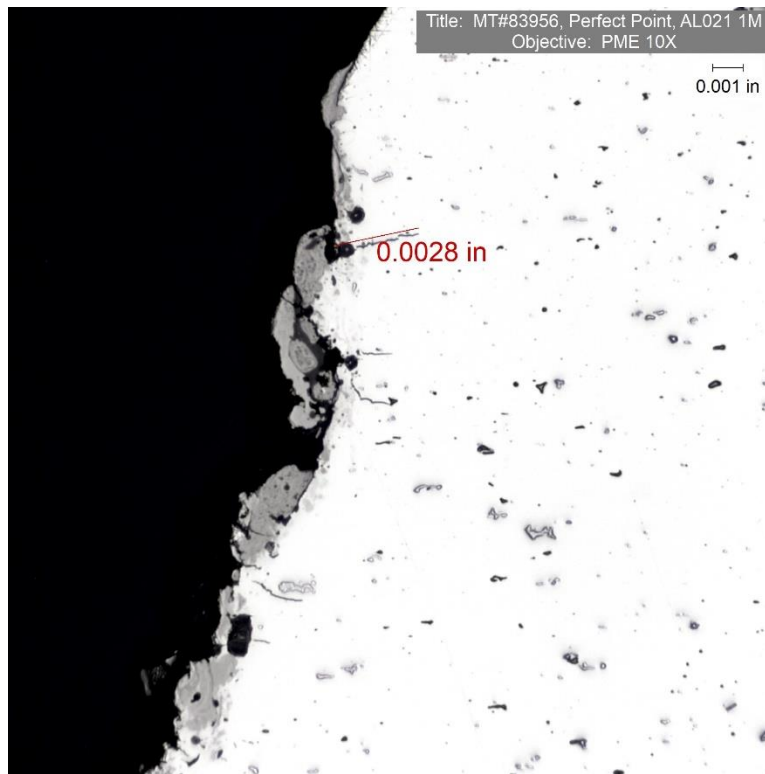


FIGURE 14. MRI Mount No.: 83956. Typical microstructure of the supplied sample AL.021 1M is presented in the unetched condition showing the full EDM cut area. Cracking was observed. 100X magnification.

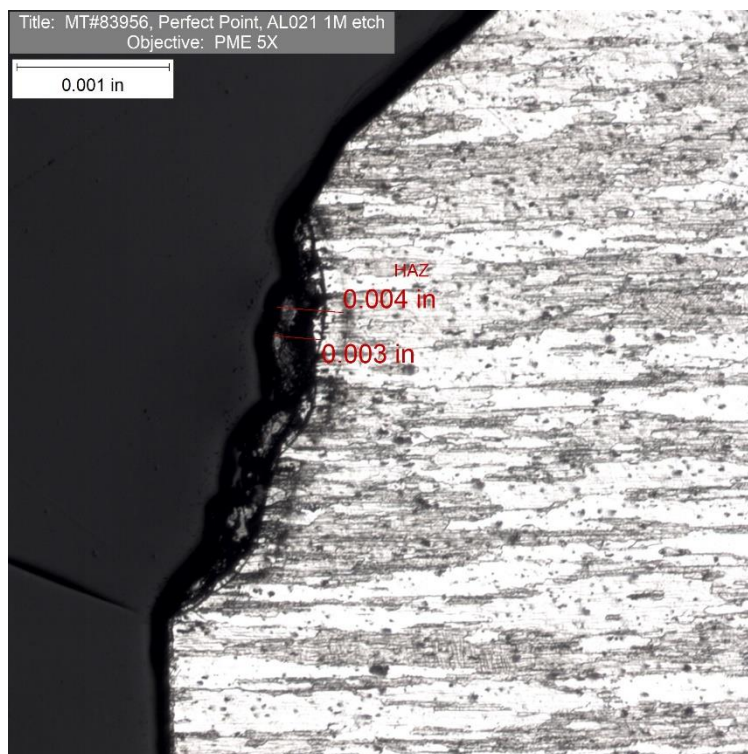


FIGURE 15. MRI Mount No.: 83956. Microstructure of the supplied sample AL.021 1M is presented in the etched condition showing EDM cut with thickest recast layer and HAZ observed, 50X magnification, Keller's etch.

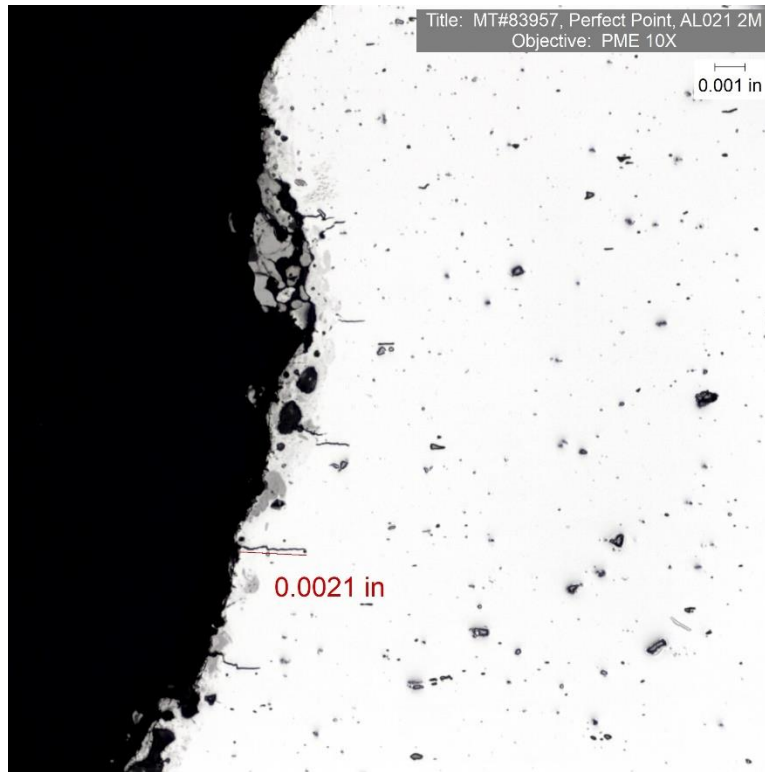


FIGURE 16. MRI Mount No.: 83957. Typical microstructure of the supplied sample AL.021 2M is presented in the unetched condition showing the full EDM cut area. Cracking was observed. 100X magnification.

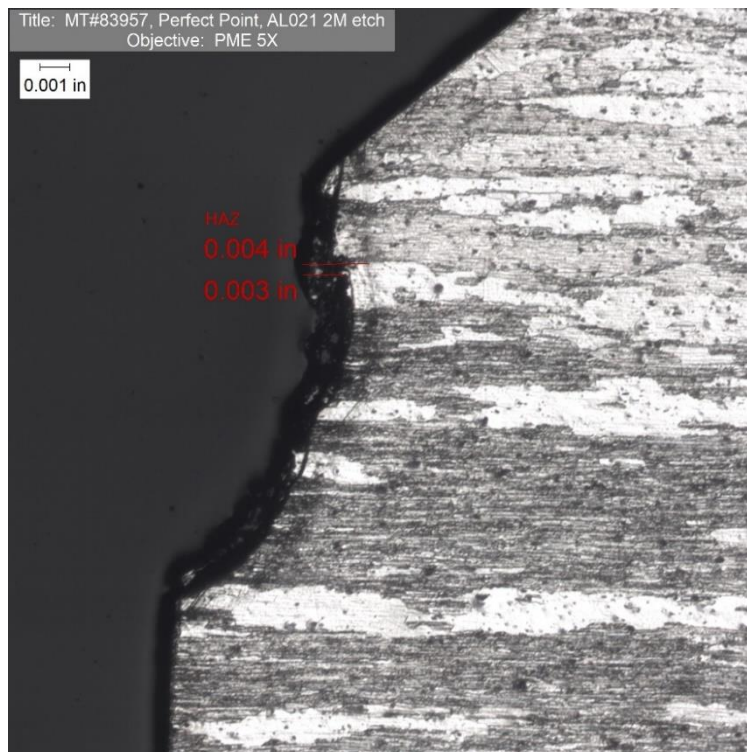


FIGURE 17. MRI Mount No.: 83957. Microstructure of the supplied sample AL.021 2M is presented in the etched condition showing EDM cut with thickest recast layer and HAZ observed, 50X magnification, Keller's etch.

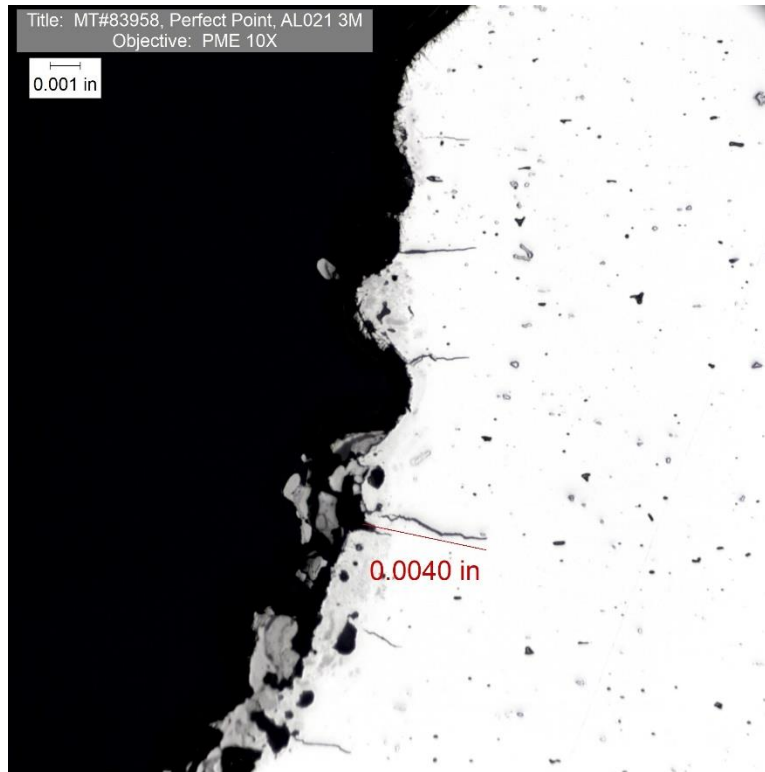


FIGURE 18. MRI Mount No.: 83958. Typical microstructure of the supplied sample AL.021 3M is presented in the unetched condition showing the full EDM cut area. Cracking was observed. 100X magnification.

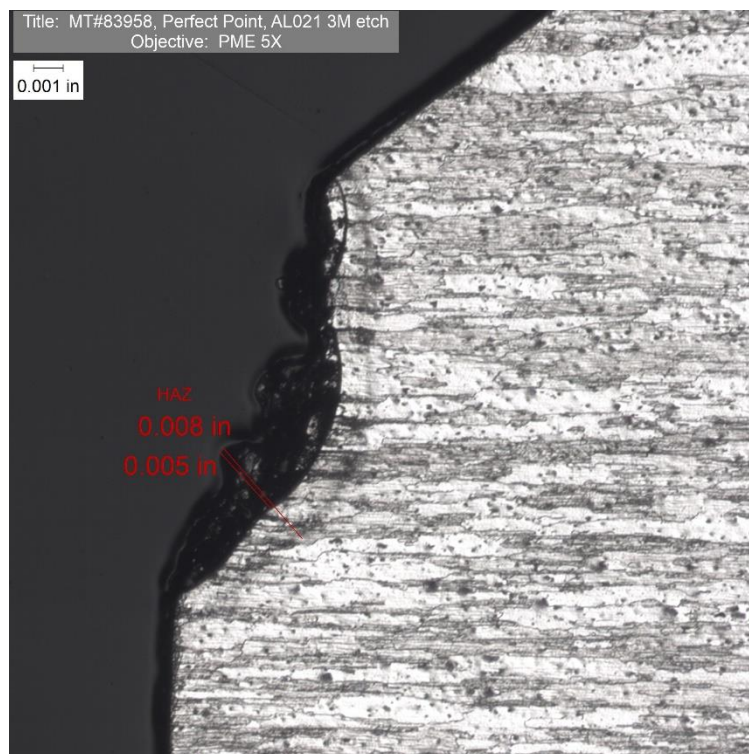


FIGURE 19. MRI Mount No.: 83958. Microstructure of the supplied sample AL.021 3M is presented in the etched condition showing EDM cut with thickest recast layer and HAZ observed, 50X magnification, Keller's etch.