Applications of Confocal Microscopes on Toolmark Analysis

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Introduction

We lack published articles demonstrating the potential of wire cutter tool mark comparisons. This study involves creating test cuts with aluminum wire using Kaiweets wire cutters. Our preliminary findings show that test cuts have a small area of no striations, or "smush", before leaving any striae. We have created a program to extract three-dimensional data, or a signature, from the test cuts, ultimately determining accuracy as a function of the area of the cut.

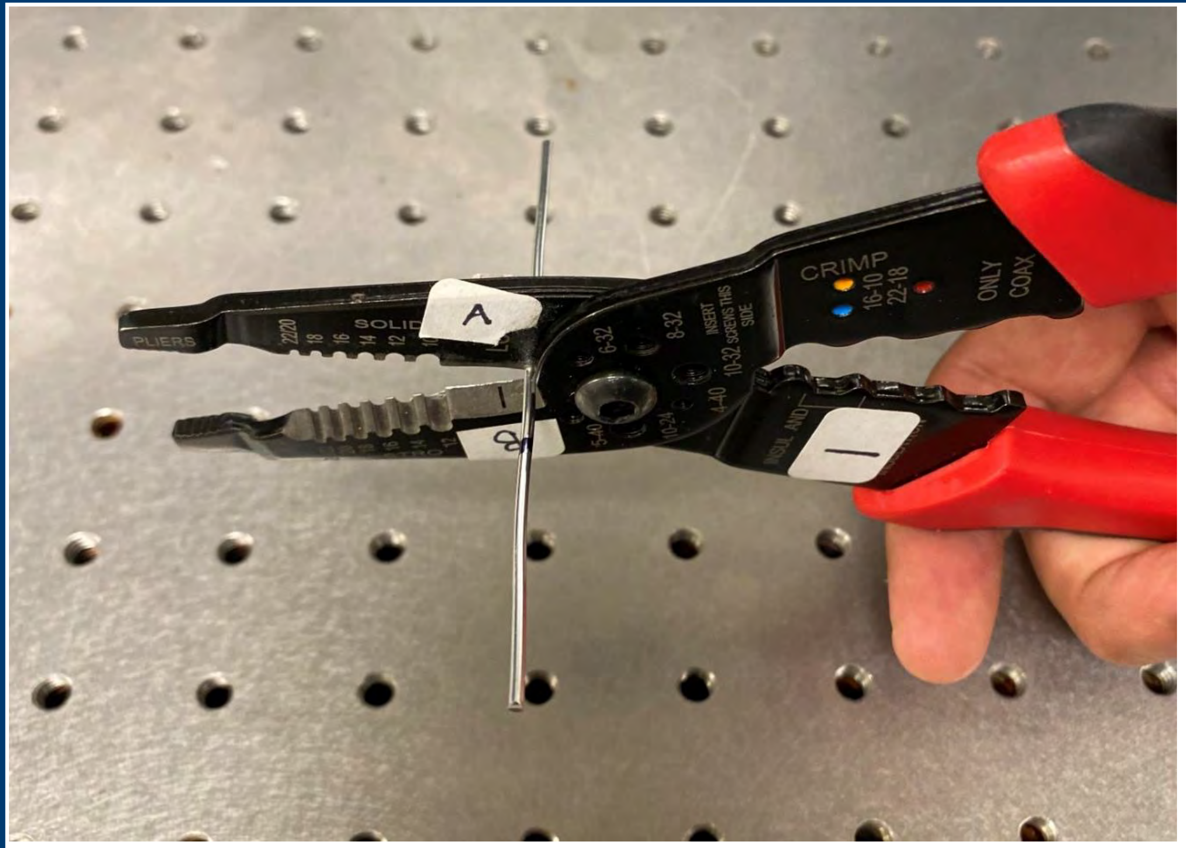
Goals

- Standardization across the field of toolmark evidence
- Finding accuracy as a function of area of the test cut
- Utilizing machine learning to make accurate statistical comparisons
- To develop a method for toolmark comparisons (specifically wire cutters)
- To be able to replicate results found on this study

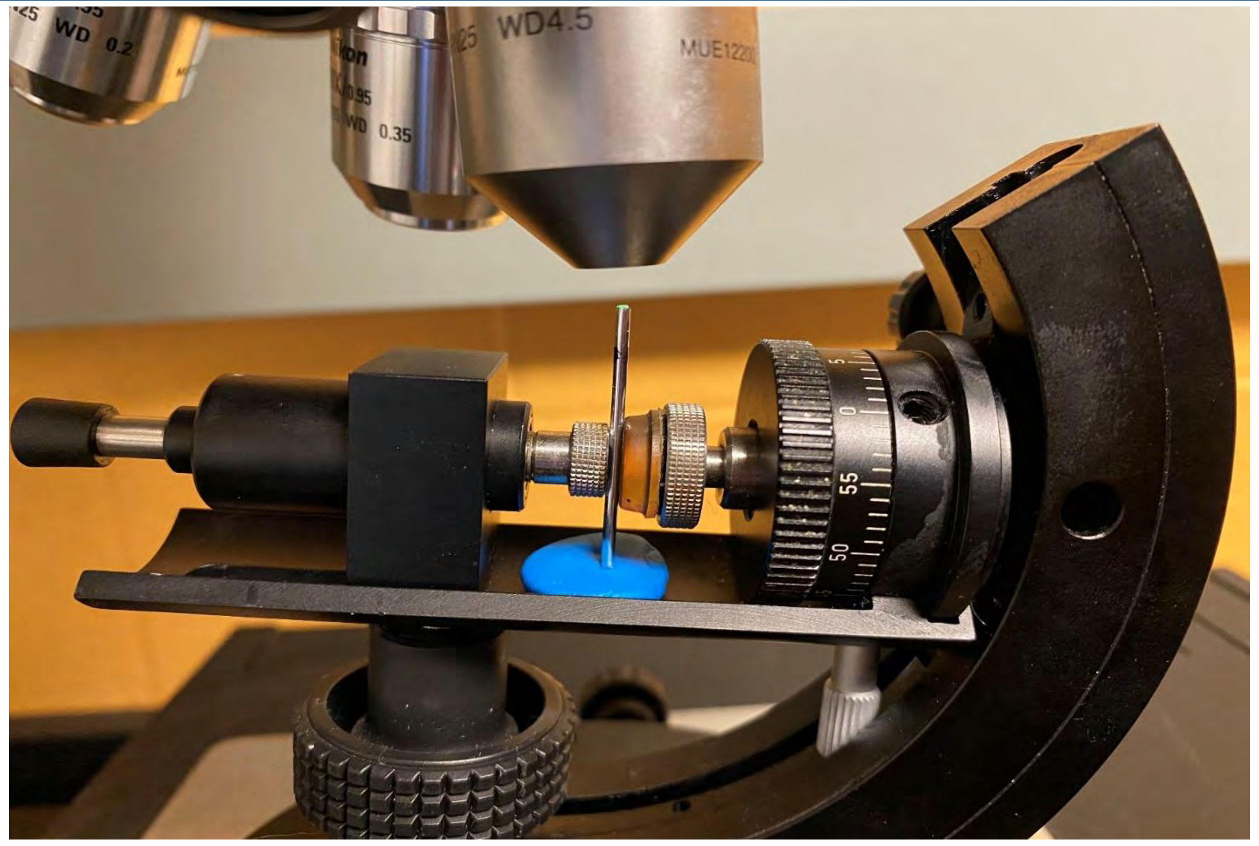
Next Steps

For our next steps we hope to scan the wire cutters themselves to start matching test cuts to unknown samples. We also have started testing cuts on aluminum sheets to view the entire cutting surface. In addition, we began creating a program to implement machine learning to make accurate comparisons between test cuts.

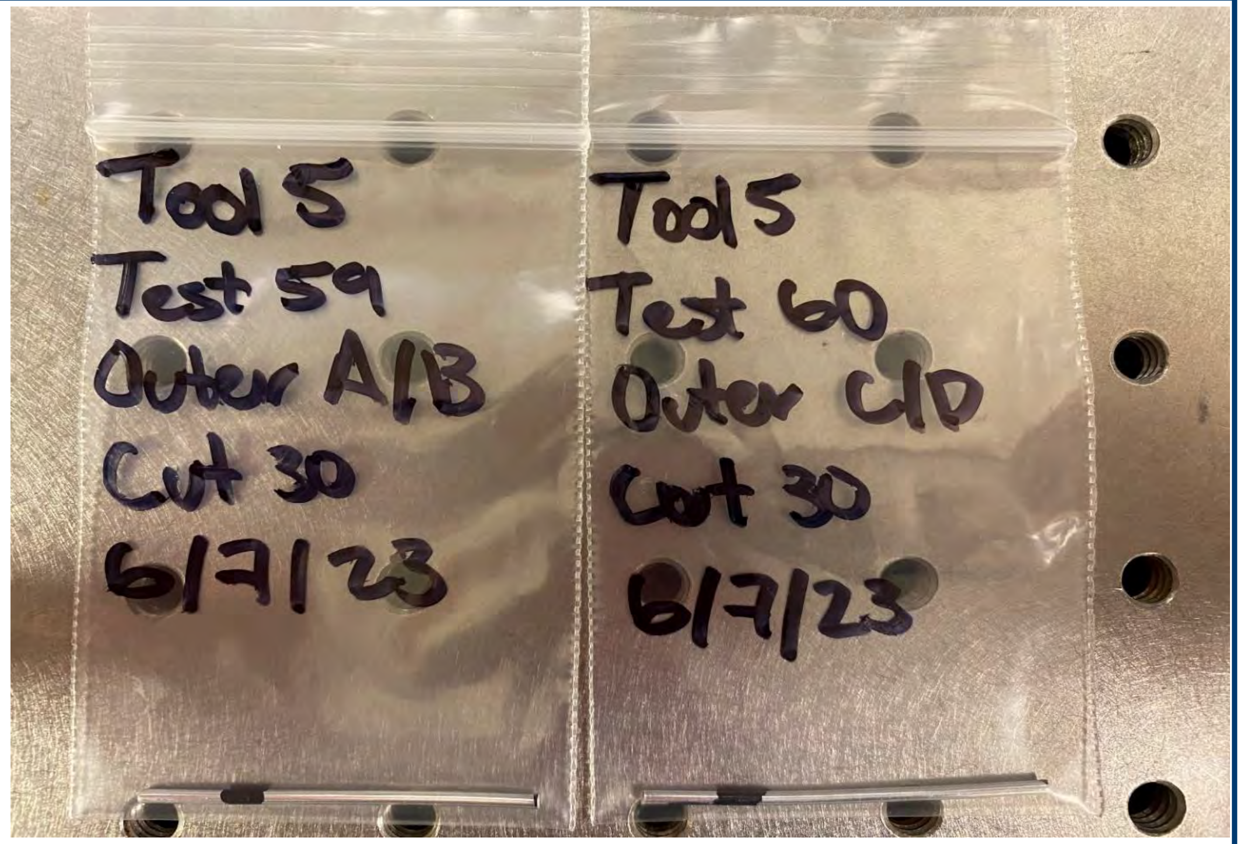
Methods Images



A Figure A shows an example of how we would get a test cut. For this image we are using pair 4 of our pliers making an AB test cut



B Figure B shows a piece of the aluminum wire sitting in the stage of the microscope. We utilize sticky tac to help keep it in place while scanning.

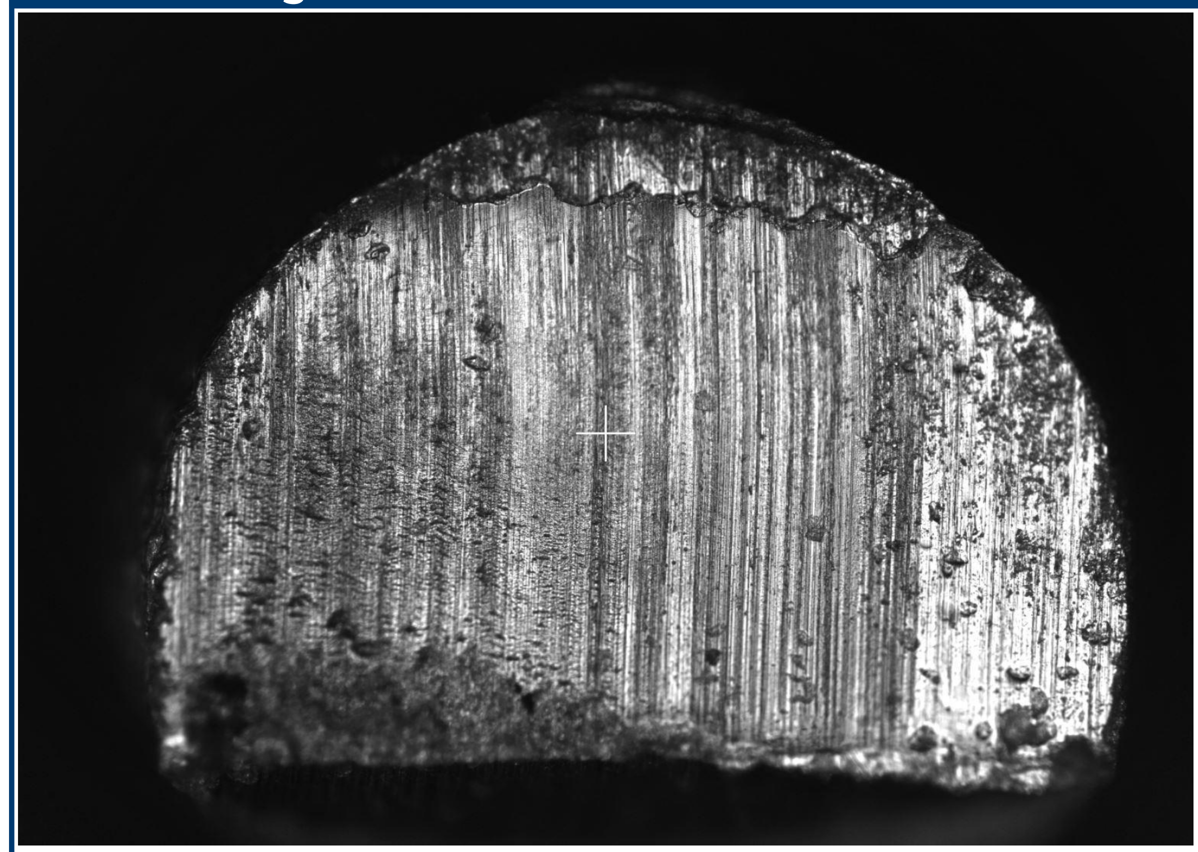


C Figure C shows our packaging method for all test cuts. On the Ziploc we label the test number, tool, edge side, and date.

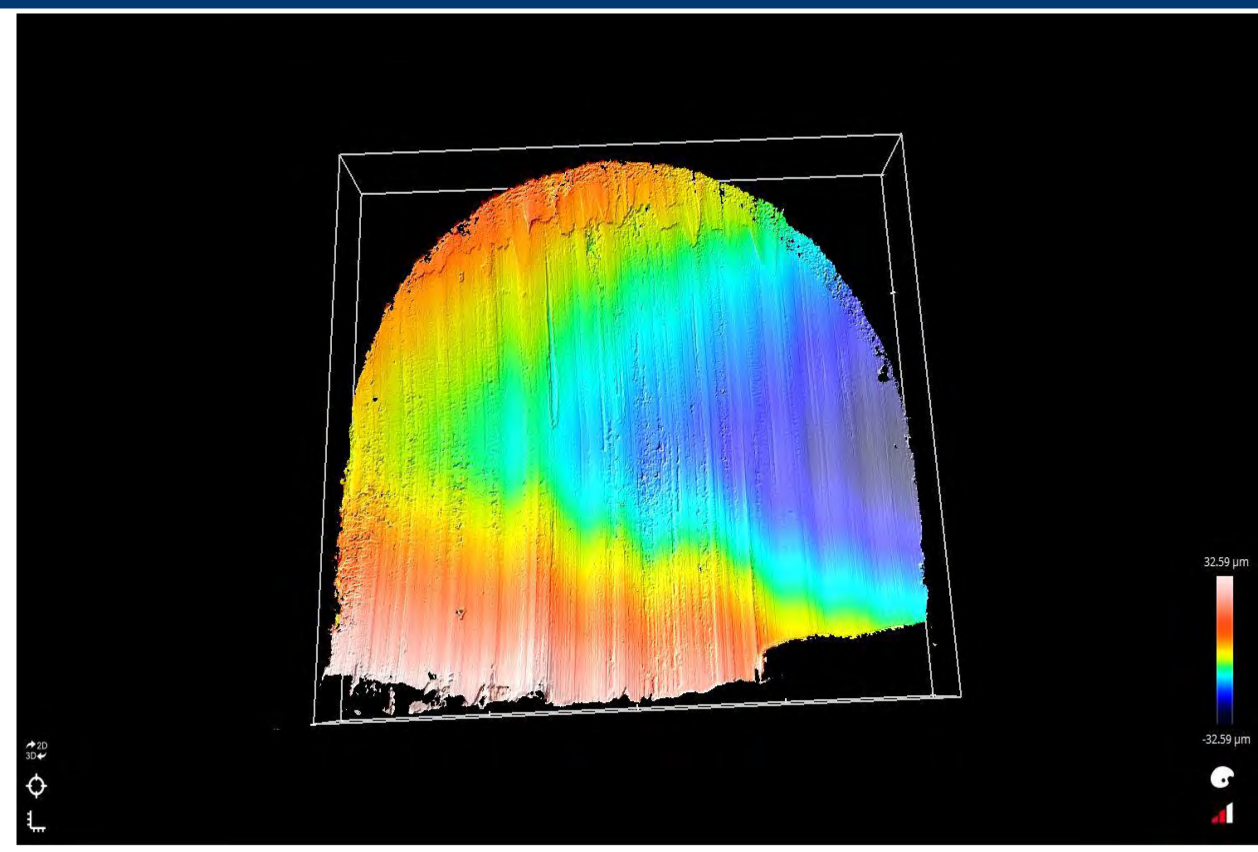
Methods Discussion

For this study we have created a method for achieving reliable scans of the aluminum wire on a confocal microscope. Our initial data collection, which consisted of four wires cut per wire cutter at three separate locations (inner, middle, and outer) for a total of 60 cuts, has shown there is some variance between the location of the test cut on the wire cutters and the scan itself. Each packaged wire has a corresponding file within an organized folder system in order to easily relocate and compare for future analysis.

Results Images



D Figure D shows an overall image of a test cut scan under the 10x optic lens on our confocal microscope.



E Figure E shows an in-depth scan of the large side of a test cut, or side A. Here you can see good striations as well as the smush.

F Figure F shows a scan that has been converted the .X3p format for statistical comparison of the test cut.

Results Discussion

Results from cross-correlation between same-source and different source signals suggest that there is a marked distinction in the values. Current results show an equal error rate of about 16%. Good quality data is the basis for any good study result. We have identified three main sources of difficulties: taking scans of the tip of the wire is challenging and often results in missing data in scans; a free-standing tip leads to vibrations and 'ripples' in the surface measurements. Correct data organization is crucial, and manual labeling of files is error-prone.

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