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MakuSafe Corporation Device Testing

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Problem Statement

MakuSafe is a startup company based out of West Des Moines, Iowa with a focus on worker safety. They have developed a wearable safety monitoring device that aims to improve workplace safety by monitoring the environmental conditions, as well as slips, trips, falls, near misses, and other potential hazards around the worker. A safety manager can then review this data and take proactive steps to improve the work environment. The device is mounted in a holster that is worn on the arm of an individual. MakuSafe needs data collected on the force required to break the holster away from a worker. The holster needs to break before a worker is injured.

This problem needs to be solved in order to maintain worker safety when wearing the device. The potential risks of injuring an employee are far greater in cost to MakuSafe than it would be to change the design of the holster. MakuSafe is a new company and is developing its own product; there is not another company that is doing research similar to this project.

Disciplines

Bioresource and Agricultural Engineering | Industrial Technology

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TSM 416 Technology Capstone Project

MakuSafe Corporation Device Testing

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Client: MakuSafe Corporation, 1201 Maple Street, West Des Moines, Iowa, 50266, https://makusafe.com/

- Contact(s): Mark Frederick, CTO, mark@makusafe.com

1 PROBLEM STATEMENT

Problem Statement

MakuSafe is a startup company based out of West Des Moines, Iowa with a focus on worker safety. They have developed a wearable safety monitoring device that aims to improve workplace safety by monitoring the environmental conditions, as well as slips, trips, falls, near misses, and other potential hazards around the worker. A safety manager can then review this data and take proactive steps to improve the work environment. The device is mounted in a holster that is worn on the arm of an individual. MakuSafe needs data collected on the force required to break the holster away from a worker. The holster needs to break before a worker is injured.

This problem needs to be solved in order to maintain worker safety when wearing the device. The potential risks of injuring an employee are far greater in cost to MakuSafe than it would be to change the design of the holster. MakuSafe is a new company and is developing its own product; there is not another company that is doing research similar to this project.

Business Case Statement

Department of Agricultural and Biosystems Engineering (abe@iastate.edu) aims to be a premier team serving society through engineering and technology for agriculture, industry and living systems. ABE welcomes opportunities to discover and improve new technologies for all stakeholders.

Undertaking this project will allow MakuSafe to have a better understanding of the force required to break the holster if it becomes snagged on something in a work environment. While there have been no incidents, MakuSafe wants to have a design that will keep workers safe. The data collected in this project will be used to recommend designs changes to the holster shape, material, or both. Anyone who is in the manufacturing or safety industry should care about this project as wearable safety devices may become the new norm.

2 GOAL STATEMENT

Our goal for this project is to provide MakuSafe Corporation with a recommendation of whether to implement their current design for the device holster. This recommendation will be backed up with verifiable data proving that the current design is conducive towards enabling workplace safety.

A. This recommendation will be based on the results of our testing and analysis. Based upon these results, we will then analyze our data and formulate a recommendation on whether the current design should be altered.
B. Specific parameters that were measured:
    - Peak load force, yield force, stress, strain
    - Breakpoint locations

- **Main Objective(s) and Specific Objectives**
    - Our main objective was to determine the forces required to break the holster.
      Specific objectives include:
        - To make recommendations on design changes if necessary
- **Rationale**
    - MakuSafe will be able to redesign their product to ensure worker safety
- **Project Scope**

  Develop, test, and analyze the strength of the holster, as well as make design changes and give recommendations for a design change.

  Our scope changed slightly because we decided to move away from analyzing the comfortability of the holster and focus entirely on the force required to break the device.

3 PROJECT PLAN/OUTLINE

Methods/Approach

- **Research:**
    - Our group researched the forces needed to be applied on certain plastics for them to break before a worker was injured
    - We referenced OSHA's website to find regulations regarding wearable devices
- **Data collection**:
    - The data we needed to collect was focused on determining the force required to break the holster and the location of the break.
    - Finite element analysis was completed using Autodesk Inventor

    - The break force data were collected using a tensile testing system
- **Skills**:
    - Knowing how to use the machinery in the TSM 240 lab
    - Knowing how to properly apply the applications needed to measure our tests
    - Knowledge of plastics from TSM 240 was used
- **Solutions:**
    - We tested the first and second generations of MakuSafe's holster design
    - Through consulting with our client, we came up with a list of appropriate deliverables
    - Our project will meet client expectations because it encompasses all aspects our client wanted to be incorporated into the project.
- **Organization:**
    - Our group met every week to discuss the progress of the project
    - We distributed tasks to each of the group members
    - The major milestones for our project were gathering initial data (10/15/18 - 11/12/18), designing tests (1/14/19 – 2/4/19), analyzing data (2/11/19 – 3/11/19), and creating recommendations (3/11/19 – 4/4/19)
    - As setbacks occurred throughout our project, our group would work together to create solutions and find an answer to each problem

4 RESULTS

We currently are recommending that MakuSafe make no changes to the 2nd generation model of the device holster. We are also acknowledging that we had to make several assumptions and concessions during testing that could impact the results. We were not able to test with injection molded parts as MakuSafe is still having them produced. As a result, we used 3D printed parts to set our test up and dial in the process. Then, we used machined plastic parts for our final testing. 3D printed parts and machined plastic do break at different forces than injection molded plastic. After conducting our testing, we believe the holster will break in a consistent manner. The holsters broke along the stress risers that MakuSafe has designed into their holster.

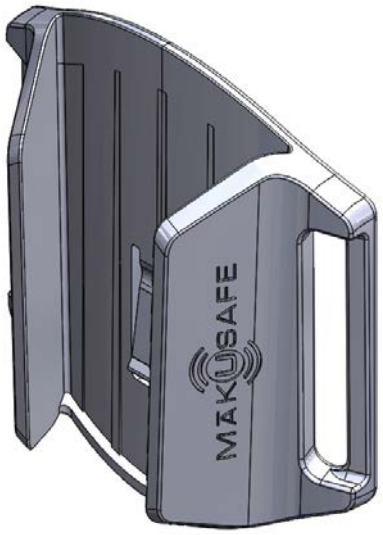
We recommend that MakuSafe conducts more testing on the holsters once they have injection molded parts in hand to confirm that the specific blend of PC/ABS fails at the same force as our machined holsters. We have documented the testing process that we developed and included this in the appendix of the report to allow MakuSafe to repeat the tests.

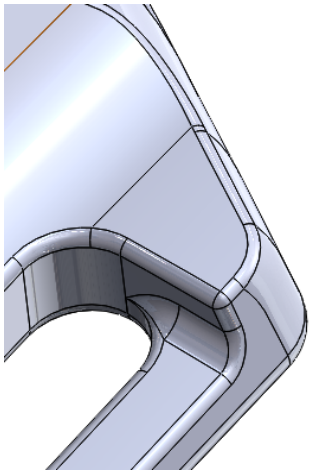
5 BROADER OPPORTUNITY STATEMENT

A. Our project can be understood by the average person because it is a simple holster that an employee would wear on his or her arm.
B. Our project will help ensure that employees are working in safe conditions by monitoring certain aspects of their workplace environments.

C. This product could potentially impact every industry by ensuring that a worker is performing tasks in a safe area.
D. Industries that would most likely use this product would be manual labor and manufacturing facilities.
E. Industries are focusing more on safety to ensure their workers can perform their jobs in a safe manner and in a safe work environment.

6 GRAPHICAL ABSTRACT





7 REFERENCES

"UNITED STATES DEPARTMENT OF LABOR." *Occupational Safety and Health Administration*, 2019, www.osha.gov/.

8 APPENDIX

Testing process:

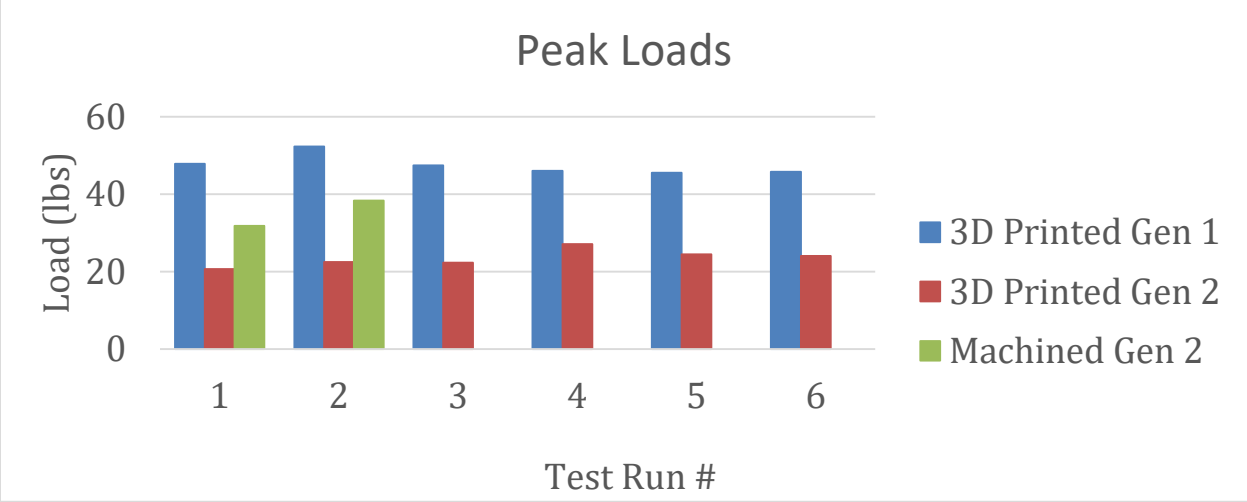
In order to complete our testing, we used MTS testing software and hardware. We attached the holsters to a 500-pound load cell using 1.5-inch nylon webbing. The webbing was attached to both sides of the holster and was pulling in opposite directions. We then pulled the holster at a constant rate of 25 millimeters per minute until the machine detected a break. The software collected the data and exported it to an excel file.

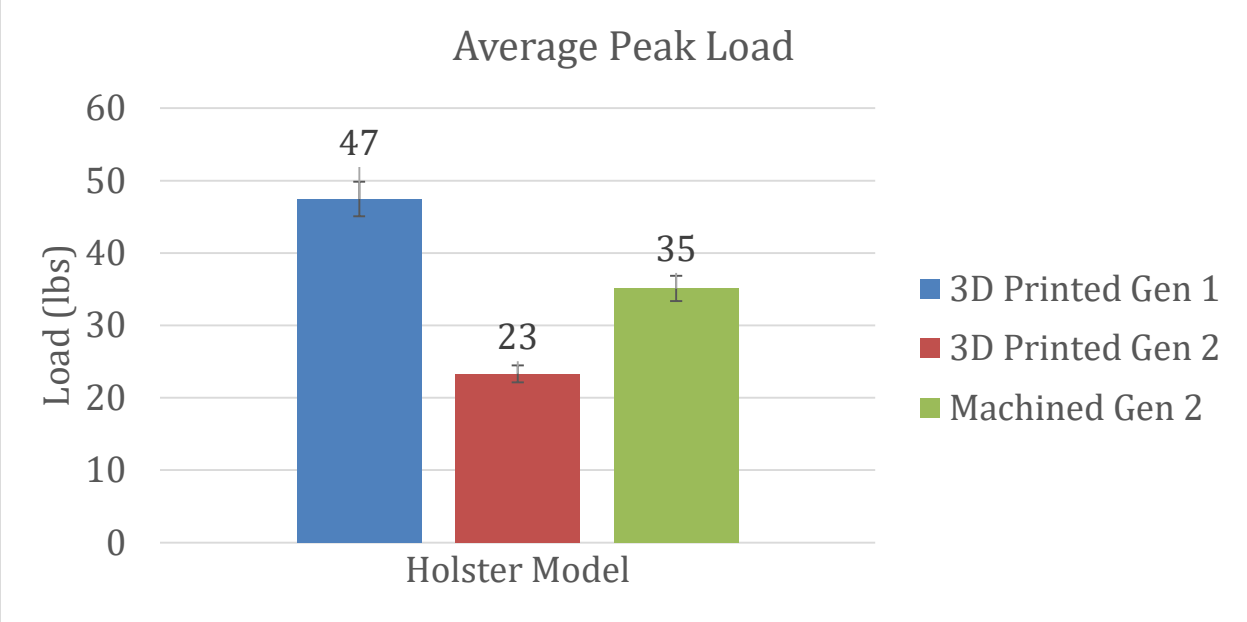
We tested 16 holsters in total. The holsters consisted of 14 3D printed plastic (7 first generation and 7-second generation) and two 2nd generation machined plastic. The 3D printed holsters are ABS plastic

with solid fill and low resolution to provide the highest plastic density for consistent testing. The machined holsters are a blend of PC/ABS plastic that Makusafe will be using for the injection molded holsters.

Testing results:

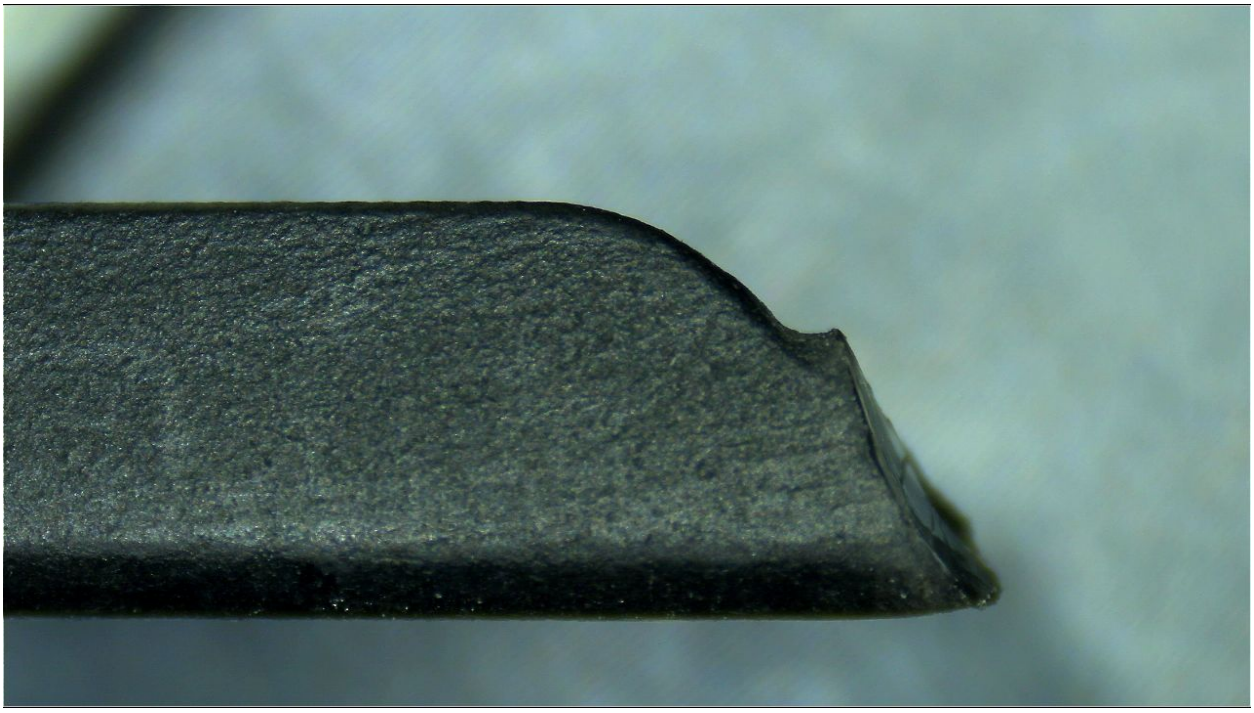
We decided the most important data collected was the peak load the holster withheld during testing. We have attached a table with the loads from the testing below.



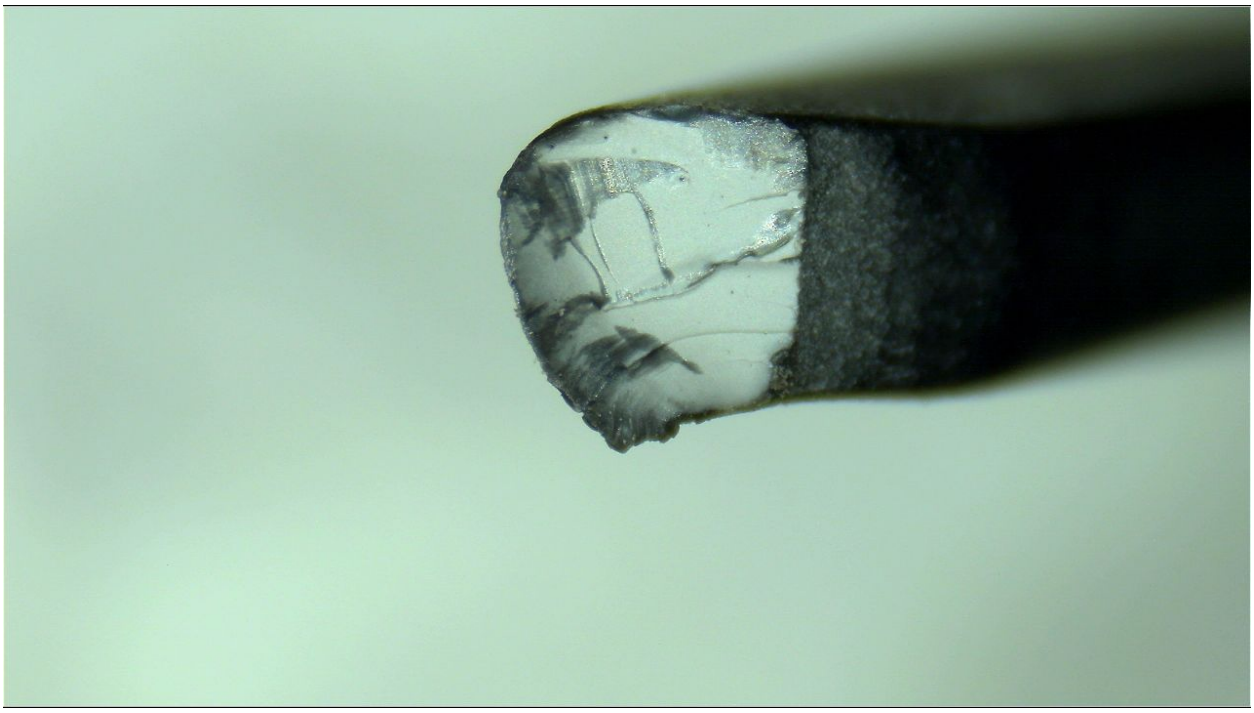


Pictures:

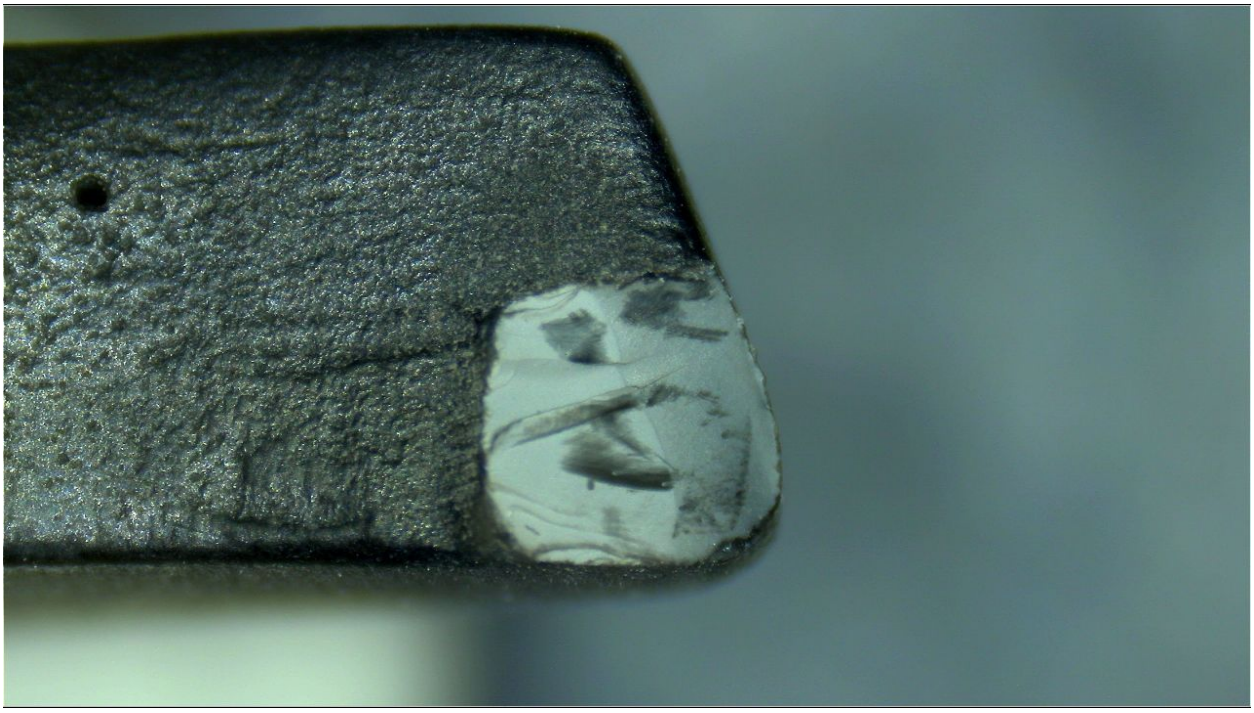
Holster with nylon webbing securing it into the jaws of the testing machine.



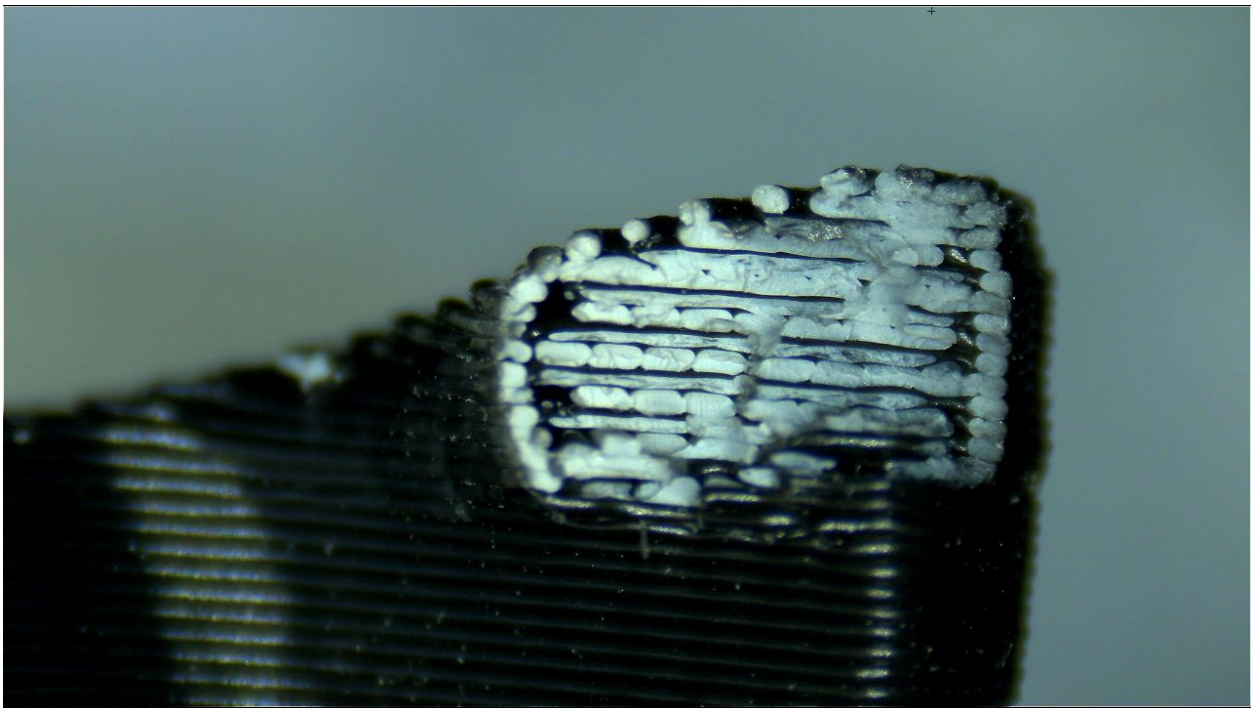
Profile view of gen 2 fracture surface (machined).



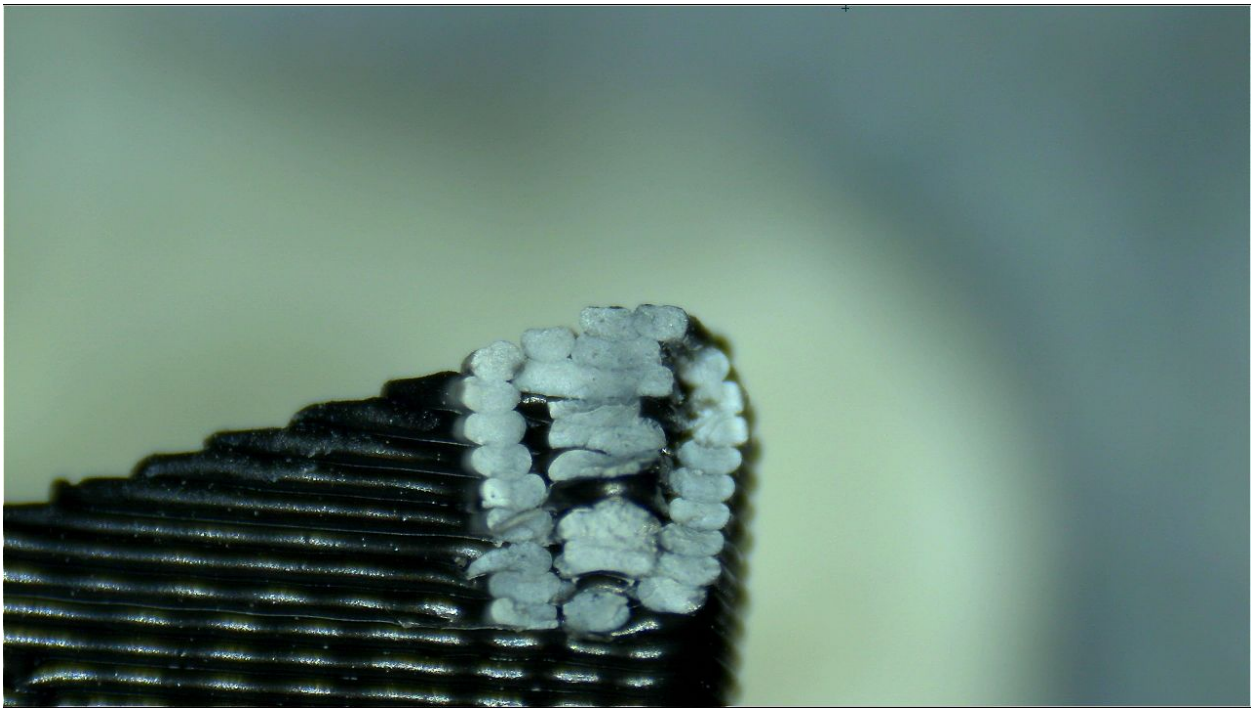
The fracture surface of Gen2 holsters (machined).



Fracture surface of gen 2 holster (machined).

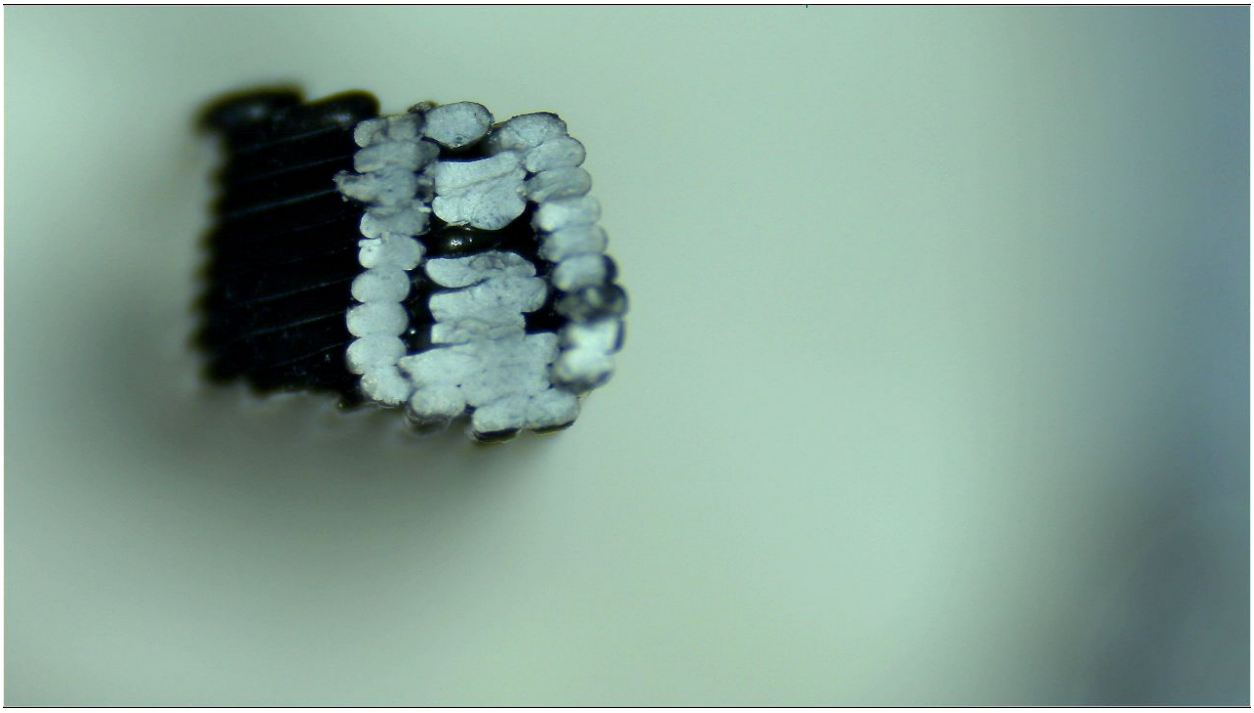


The fracture surface of Gen1 holster (3D printed).



The fracture surface of Gen2 holsters (3D printed).

Profile view of Gen2 holsters (3D printed).



The fracture surface of Gen2 holsters (3D printed).