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Fiducial Marker Apparatus for Precision Placement FMAPP

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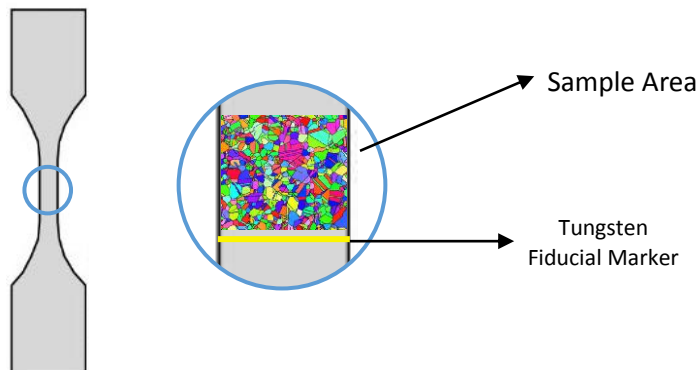
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Abstract

To create the next generation of metallic alloys for stronger bridges, more durable planes, and space exploration, we first need to understand the fundamental link between the way the metal is made and how it performs. This requires scientists to investigate material response and properties on a granular level. An exciting prospect for characterizing a materials microstructure is to readily combine two different techniques, High energy X-ray diffraction microscopy (HEDM) and Electron microscopy (EM), to take advantage of both of their strengths.

Introduction

In order to fully characterize a material's microstructure, both HEDM and EM techniques need to be performed on the same region of the sample. To achieve this, a fiducial marker must be placed on the sample so scientists can identify the same region in both techniques. These fiducial markers need to be permanently placed with a precision of a few 10's of microns, no more than the width of a human hair.



*Titanium sample used for testing
The dimensions of sample cross
section: 1 mm x 1 mm.*

Method

To address this problem, an apparatus was designed for the precision placement of fiducial markers on many replicate samples. Three designs were hypothesized and evaluated based on two main ideas, (1) simplicity and (2) adaptability.

(1) *Simplicity* in the axis of free motion, and number of parts to limit the buildup of additive uncertainties.

(2) *Adaptability* was a concern due to the varying sample dimensions and changing fiducials for the varying sample materials. Furthermore, adaptability allows for unforeseen future experiments to take advantage of precision placement.

SolidWorks was used to utilize to further design and analysis the concept chosen.

Results

Concept 1 (the chosen one)

This concept uses two axis of motion, x and y, to position the fiducial under the sample, and one axis of motion, vertical, to bring the two together. Uses Glue as the connective medium between sample and fiducial marker.

Pros: Highly adjustable, uses pre-existing parts, cost effective, can be manufacture in time

Cons: time consuming

Concept 2

This concept operates much the same way as concept 1, however instead of x and y axis track pads to position the fiducial under the sample. Concept 2 uses the idea of predetermined dimensions to premanufacture shims to position the fiducial under the sample. Uses Glue as the connective medium between sample and fiducial marker.

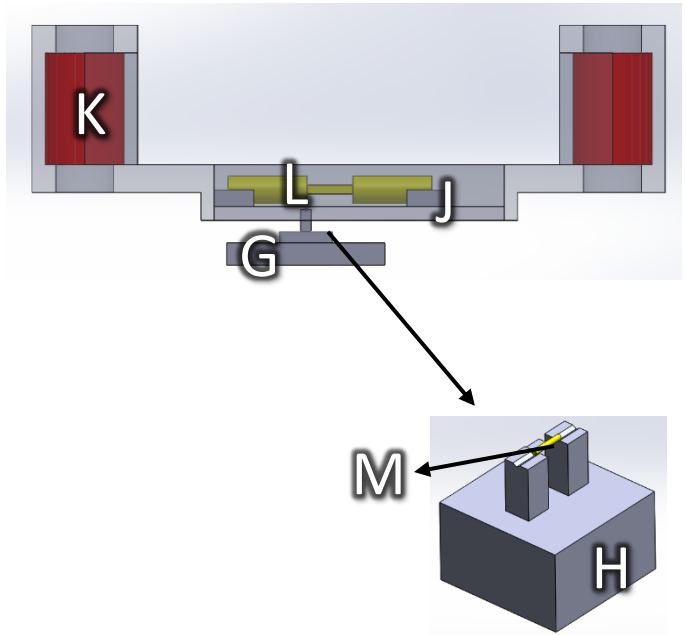
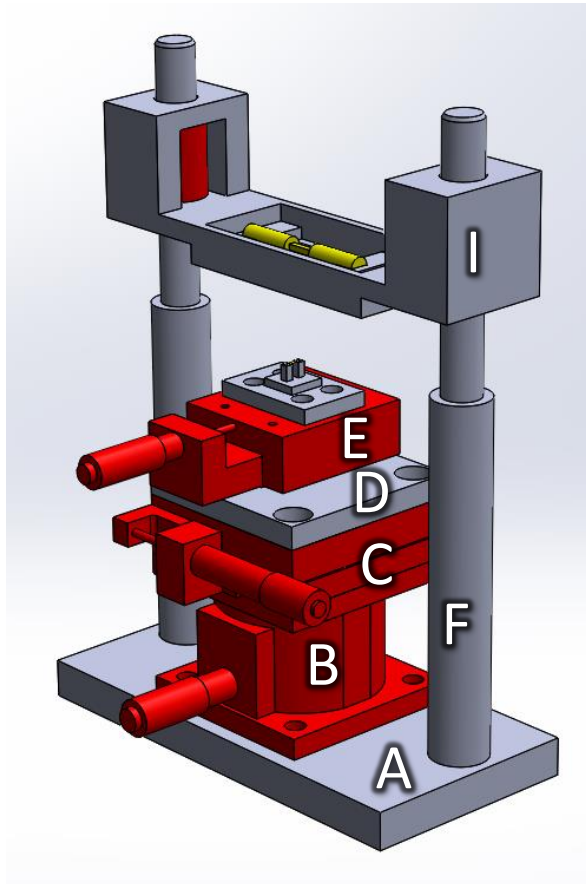
Pros positioning accuracy is only limited by machining accuracy

Cons new shims will have to be machined if a new variety of sample is to be tested on,

Concept 3

This concept, like concept 1 and 2 uses glue as the connection medium between sample and fiducial. However, this concept explored the idea of combining the glue and the fiducial before applying it to the sample. To test the viability of this design, fine “sand” was mixed into glue then applied to a range of metallic surfaces, what this showed is that the factors that go in to the application process required to obtain the same size and shape fiducial marker proved to be too complicated to proceed with when taking into consideration the relative simplicity of the previous two designs.

The final design takes advantage of three preexisting micrometer stages for translation along the X, Y, and Z axis, which move the fiducial marker under a fixed sample. Once the desired position is obtained, the sample is lowered until it is close to the marker using linear ball bearing sleeves on guide posts. The Z-axis micrometer is then used to raise the fiducial marker to meet the sample. This feature will eliminate any unneeded stress on the sample and fiducial caused by the weight of the sample apparatus.



Red: Preexisting / ordered parts (5)
Yellow: Sample and fiducial marker (2)
Gray: New designed parts (9)

- A:** Apparatus base
- B:** Z-axis translation stage
- C:** X-axis translation stage
- D:** X-, Y-axis adapter plate
- E:** Y-axis translation stage
- F:** Guide posts
- G:** Fiducial holder adapter plate
- H:** Fiducial holder*
- I:** Placement slide
- J:** Sample holder*
- K:** Liner ball bearing sleeve
- L:** Sample
- M:** Fiducial marker

First, the sample being tested on will be secured on the vertical slide using parts pre-machined based upon the dimensions of the sample. The fiducial is then positioned under the sample using two micrometer track pads. At this point, glue is applied to the fiducial and the sample is placed on top via the guide posts.

**H & J, interchangeable, subject to sample being used*

Summary

Concept 1 was chosen due to its high adjustable features, while keeping with its main function, precision placement of multiple fiducial markers on multiple samples. It will be manufactured for the start up of CHESS in October 2019.

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Schematics

