LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

LIGO-T1000528-v1 *LIGO* September 8, 2010

Tiltmeter Knife-Edge Surface Treatment Comparison

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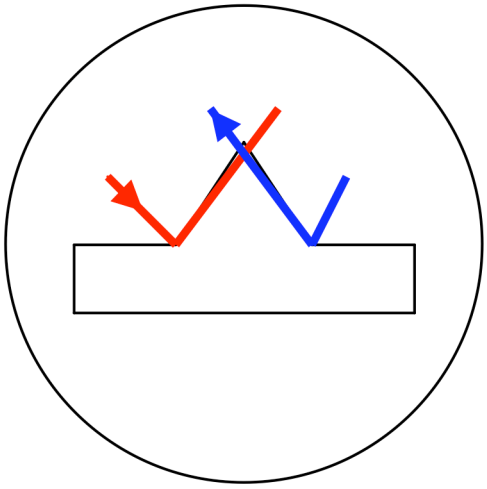
Abstract:

Electron microscope measurement of different surface treatments for the tungsten carbide knife-edge of the Tiltmeter.

1 Introduction

The purpose of electron beam microscopy inspection of the Tiltmeter knife-edges is to test the effectiveness of the process steps like polishing, diamond like carbon (DLC) chemical vapor deposition (CVD) coating, and the DLC physical vapor deposition (PVD) coating. The job was to examine the differences between the unpolished, uncoated knife-edge and the three options mentioned above to determine the relative advantages of the different methods, and if polishing the knife-edge was necessary. Observations were made using a standard electron microscope (SEM) and photographing the four knife-edges, which were made using the left over material from the new cutting schematic (see image below). The knife-edges were:

- unpolished and uncoated,
- polished and uncoated,
- polished and DLC CVD coated, and
- polished and DLC PVD coated.

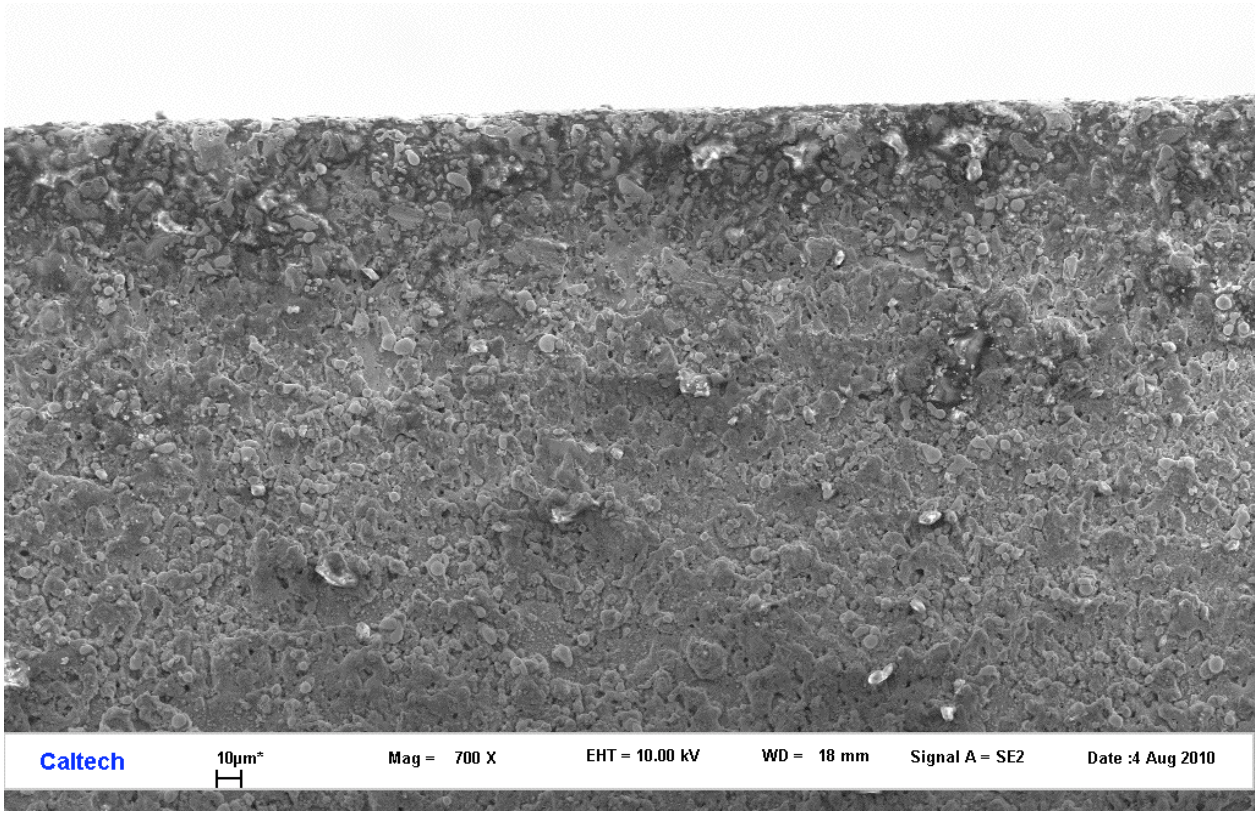


Cutting schematic of the new tungsten carbide knife-edge for the Tiltmeter.

2 Unpolished and Polished Knife-Edges

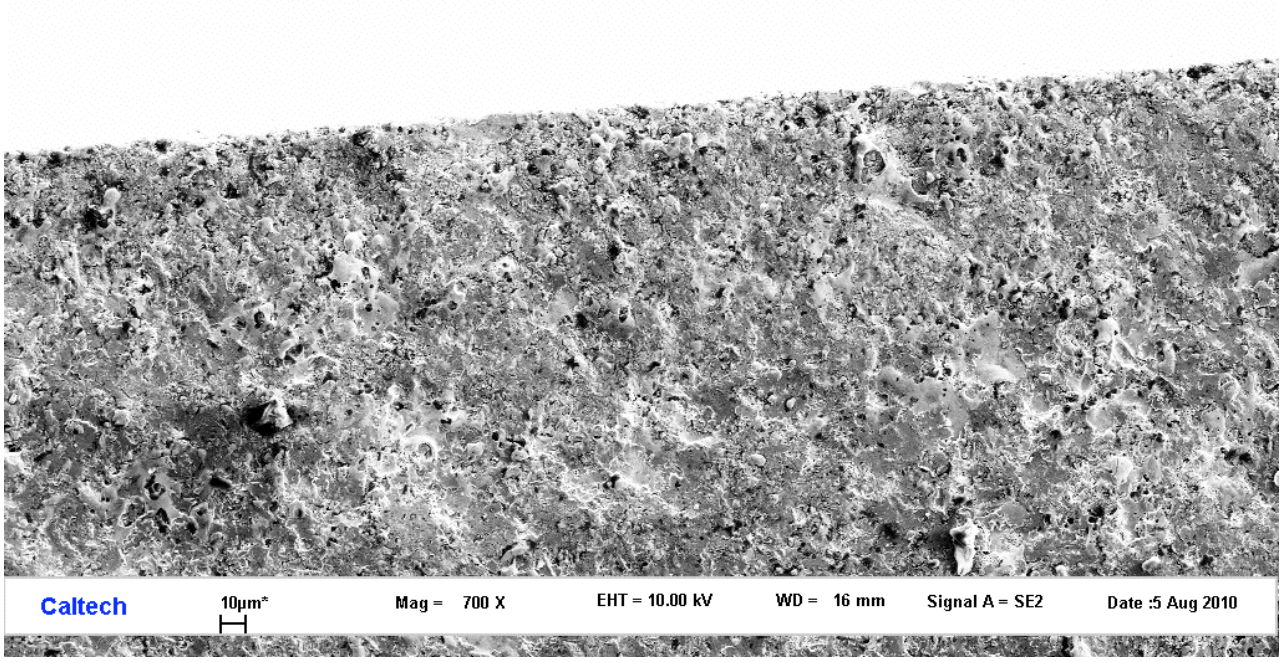
The example structures below confirmation that polishing the knife-edge removes protrusions from the unpolished knife-edge.

2.1 Unpolished Knife-Edge



The image above was taken of the unpolished, uncoated knife-edge and has protrusions along the blade.

2.2 Polished Knife-Edge



The image above was taken of a polished, uncoated knife-edge and does not contain protrusions along the blade as seen previously on the unpolished knife-edge.

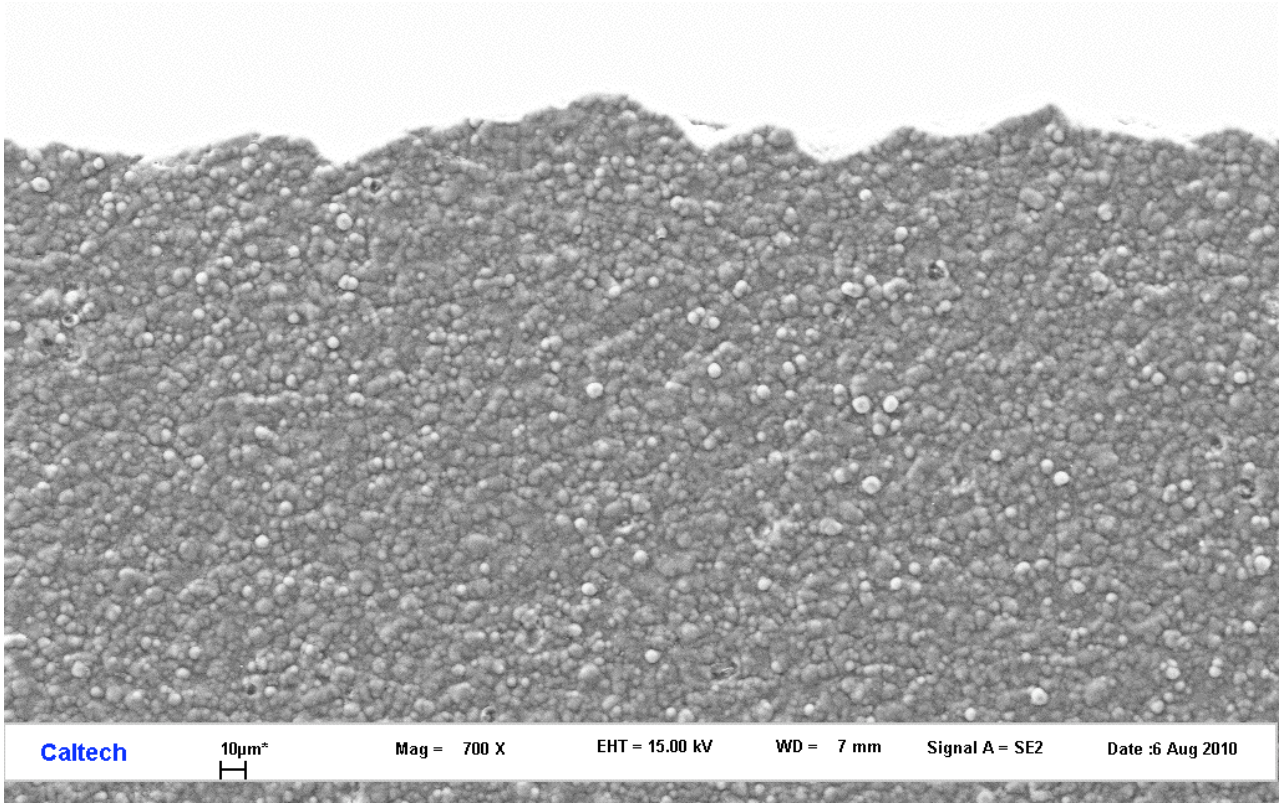
The micro-ball polishing method is useful and does not damage the knife-edge.

3 DLC CVD Coated and DLC PVD Coated Knife-Edges

From the example structures below it appears that the DLC CVD coating is better, however from the information given by LAFER, the manufacturer, it was concluded that the DLC PVD is to be used for the first knife-edge and DLC CVD will be used in a second prototype.

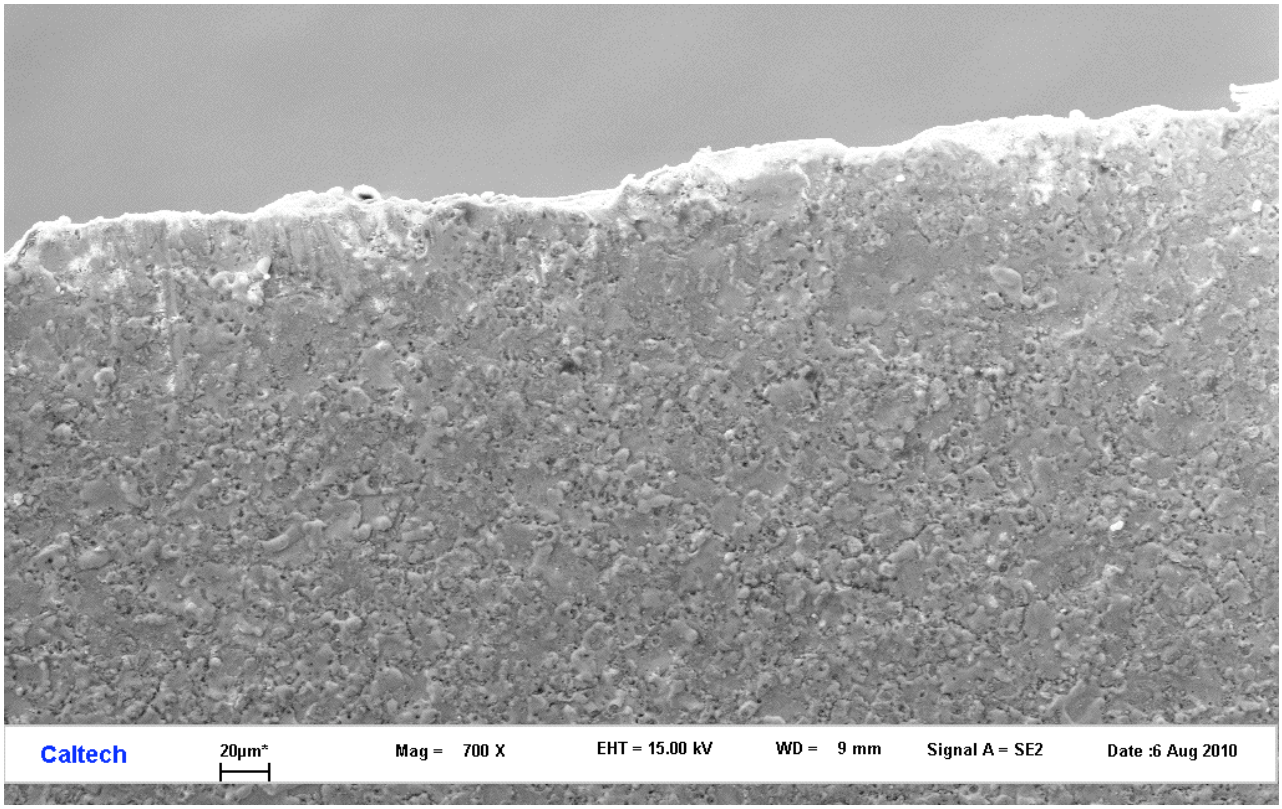
Using wire electrical discharge machining (EDM) produces more surface tension than grinding and it was suggested that the DLC CVD coating, which is a process that adds even more surface tension, may have a problem with high surface tension. Due to the combination of these surface tensions, it was decided to coat the knife-edge to be implemented into the tiltmeter using DLC PVD.

3.1 DLC CVD Coated Knife-Edge



The image above was taken of the DLC CVD coated knife-edge. The DLC CVD structure given by LAFER, the manufacturer is: 2.8 um of Carbon CVD. The coating appears to have conformed perfectly to the surface.

3.2 DLC PVD Coated Knife-Edge



The image above was taken of the DLC PVD coated knife-edge. The DLC PVD structure given by LAFER, the manufacturer, is: Cr flash + glassy WC (2.5 um) + 0.5 um of Carbon CVD.

The coatings have more structure, but the manufacturer tells us that this is normal.