

Gouging-Abrasion Testing Apparatus

Project Statement and Background

Deep cryogenics is a -190°C cold treatment process that has been proven to permanently *reduce wear, fatigue and corrosion* by 20-70% [1] in metal, metal-matrix and additive manufactured items by altering atomic-level grain structures

Deep Cryogenics International has identified that a *gouging-abrasion test* is the *most industrially significant* mode of testing the wear resistance of their cryogenically treated materials.

ASTM Standard G81-97a defines test criteria for large scale gouging-abrasion testing. More recent work by J.A. Hawk (1997) scaled down the ASTM standard to a laboratory scale configuration which serves as the basis for our apparatus.

Requirements

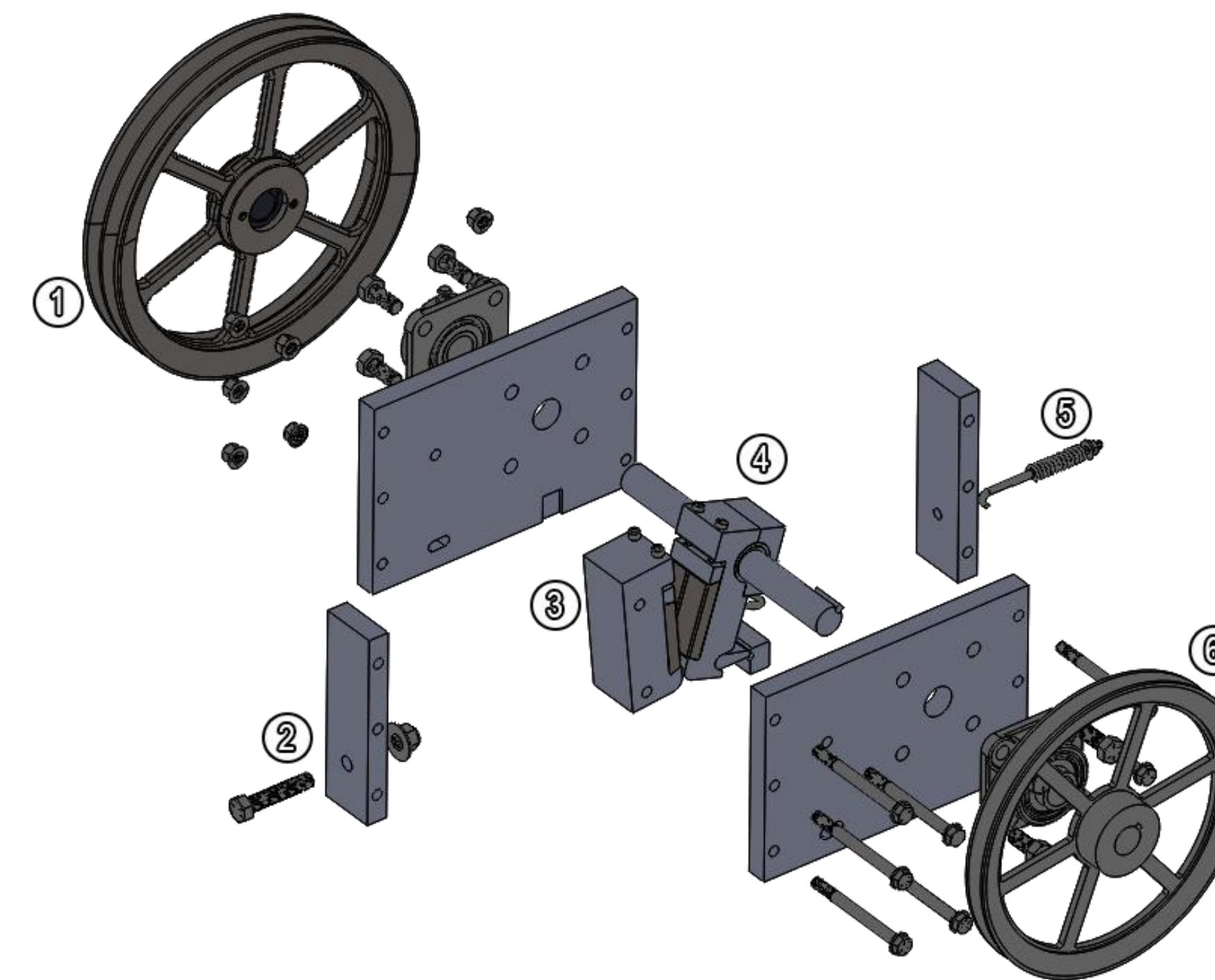
ASTM G81-97a: [2]

- *Wear Plate Dimensions: 150x70x20 mm*
- *Feed Opening: 150 mm*
- *Minimum Jaw Opening: 3.2 mm +/- 0.075*
- *5.2 kW (7HP) Electric Drive Motor*
- *Hopper Capacity: 225 kg*
- *Rock Catch Capacity: 225 kg*
- *Average Input Rock Diameter: 25 – 50 mm*

Hawk (1997): [2]

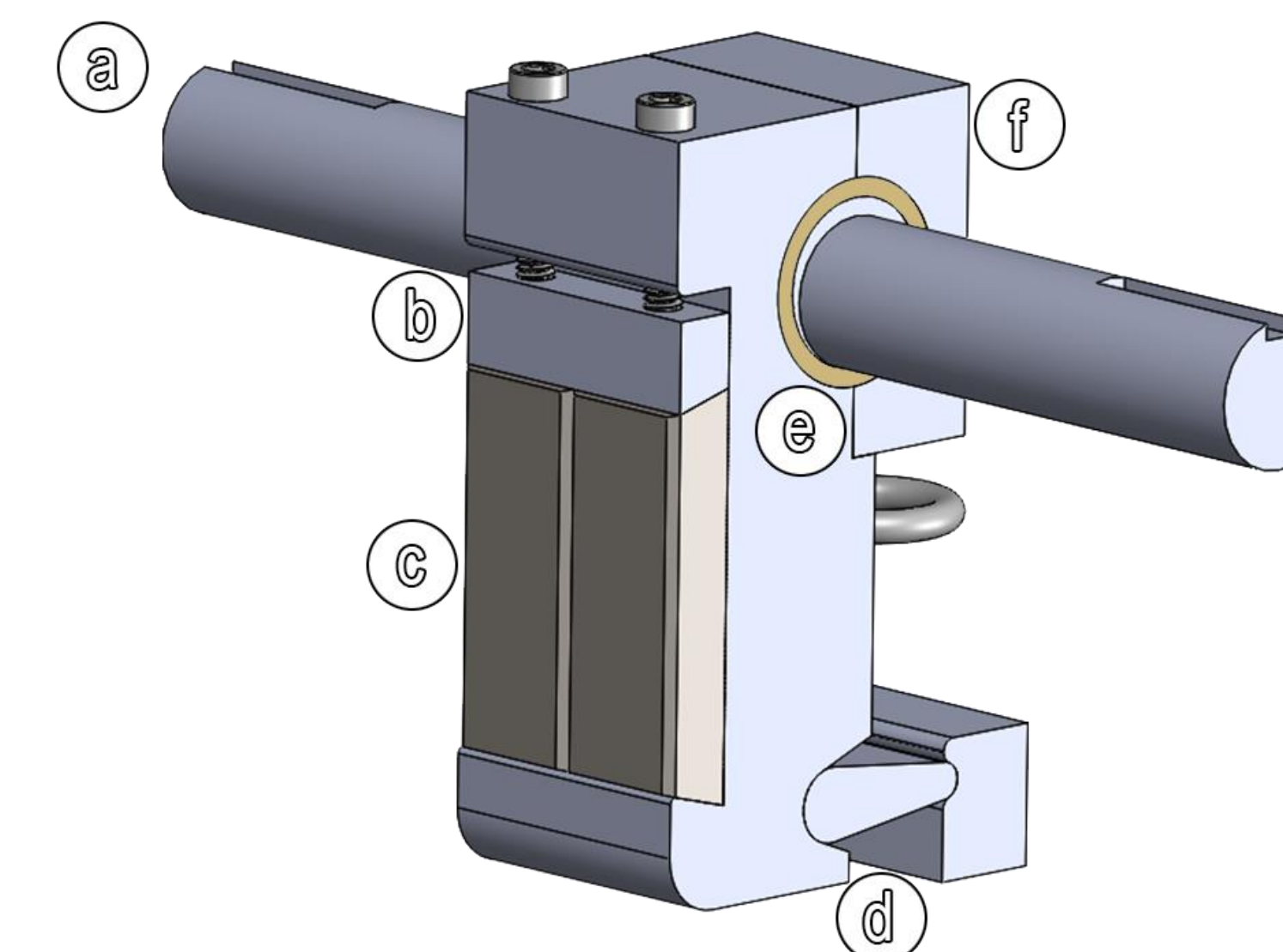
- *Wear Plate Dimensions: 75x25x12.5 mm*
- *50mm feed opening*
- *Minimum Jaw Opening: 3.2 mm +/- 0.075*
- *3.7 kW (5HP) Electric Drive Motor*
- *Hopper Capacity: 12 kg*
- *Rock Catch Capacity: 12 kg*
- *Average Input Rock Diameter: 20 mm*

Machine Design

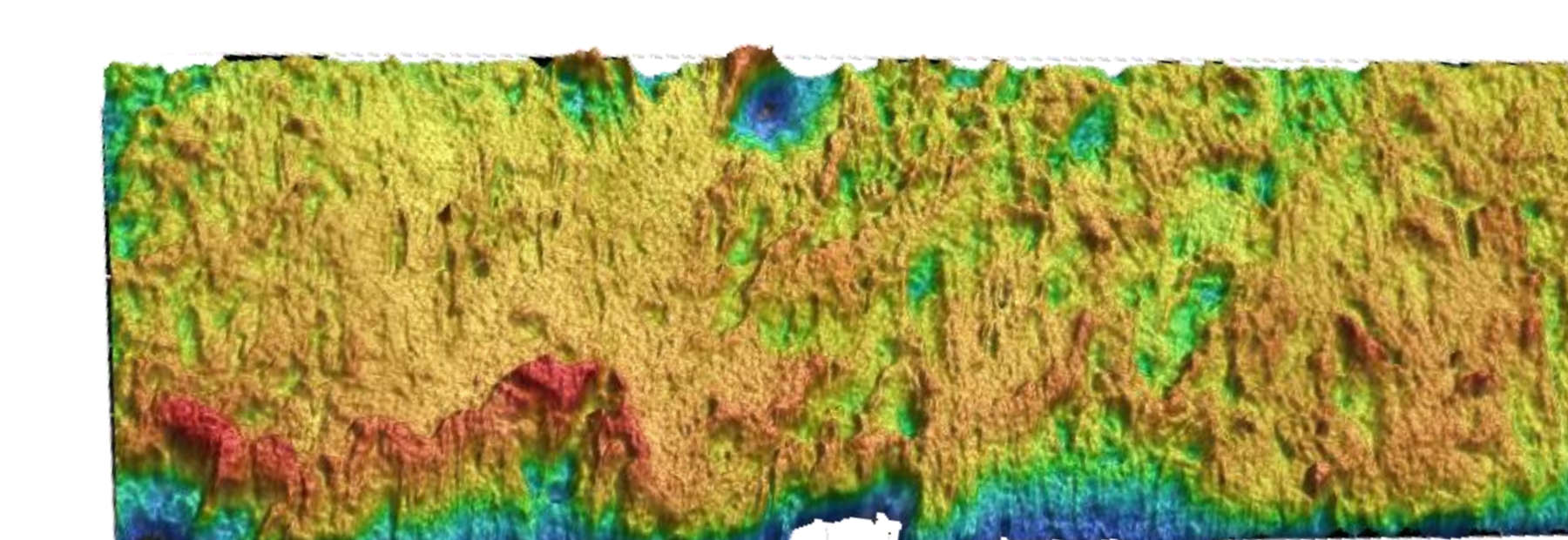
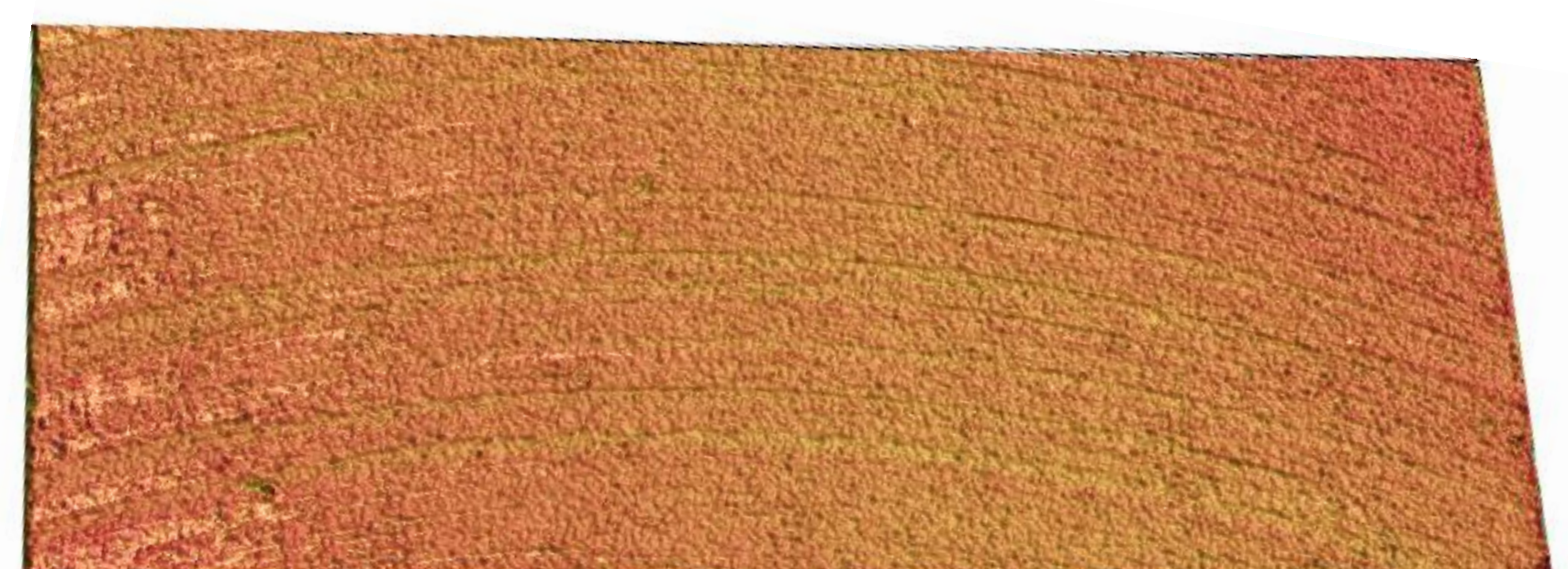
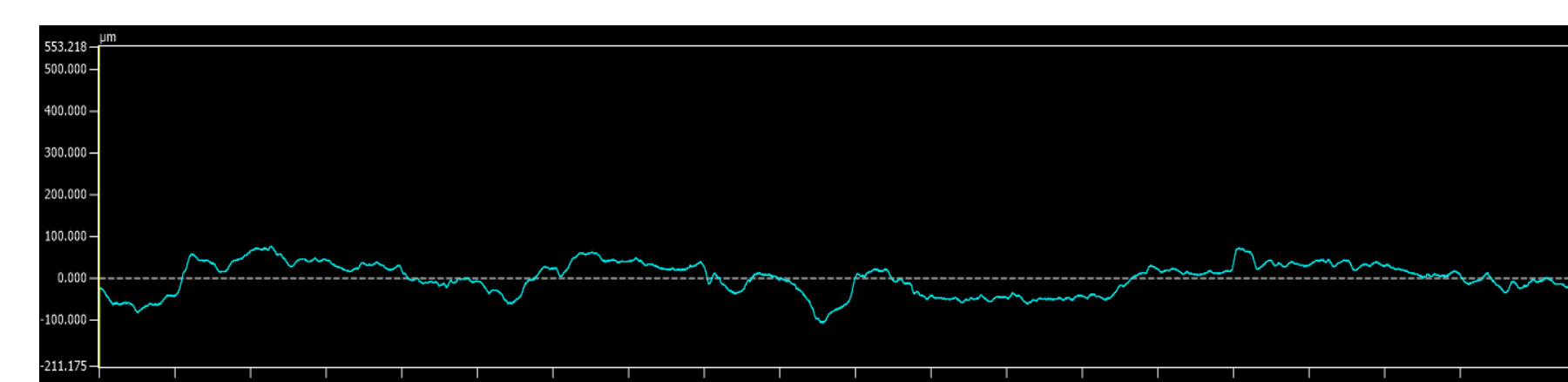
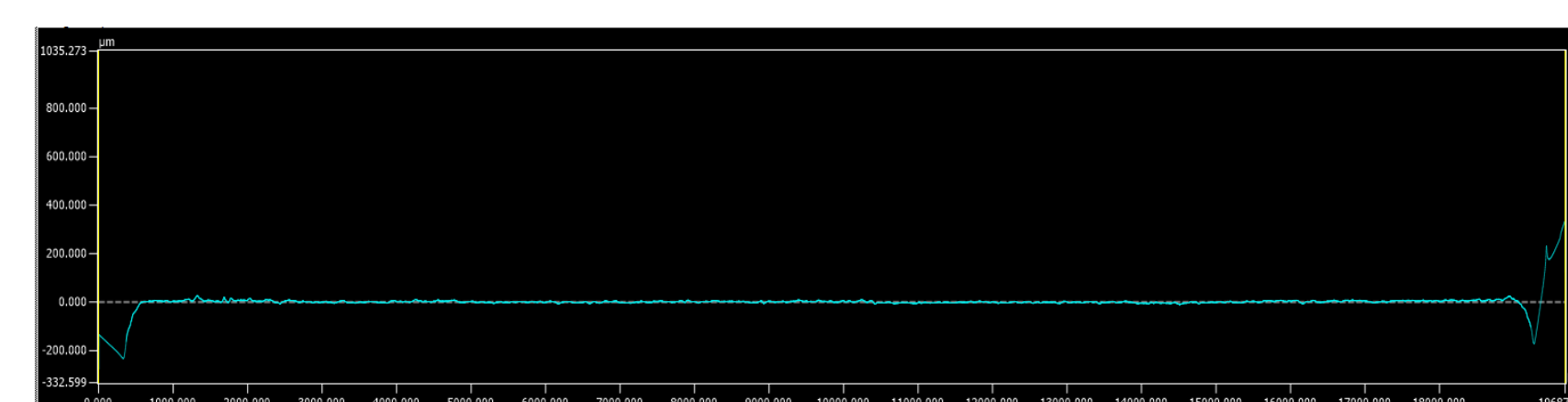
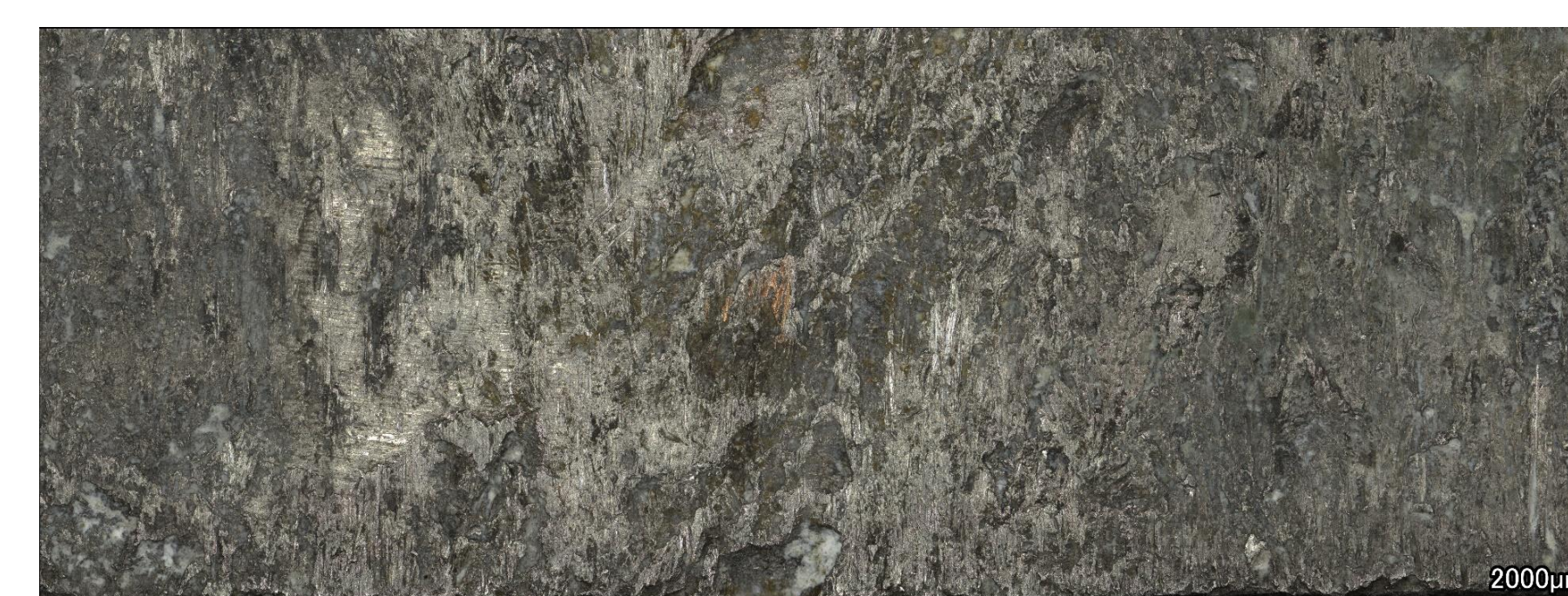
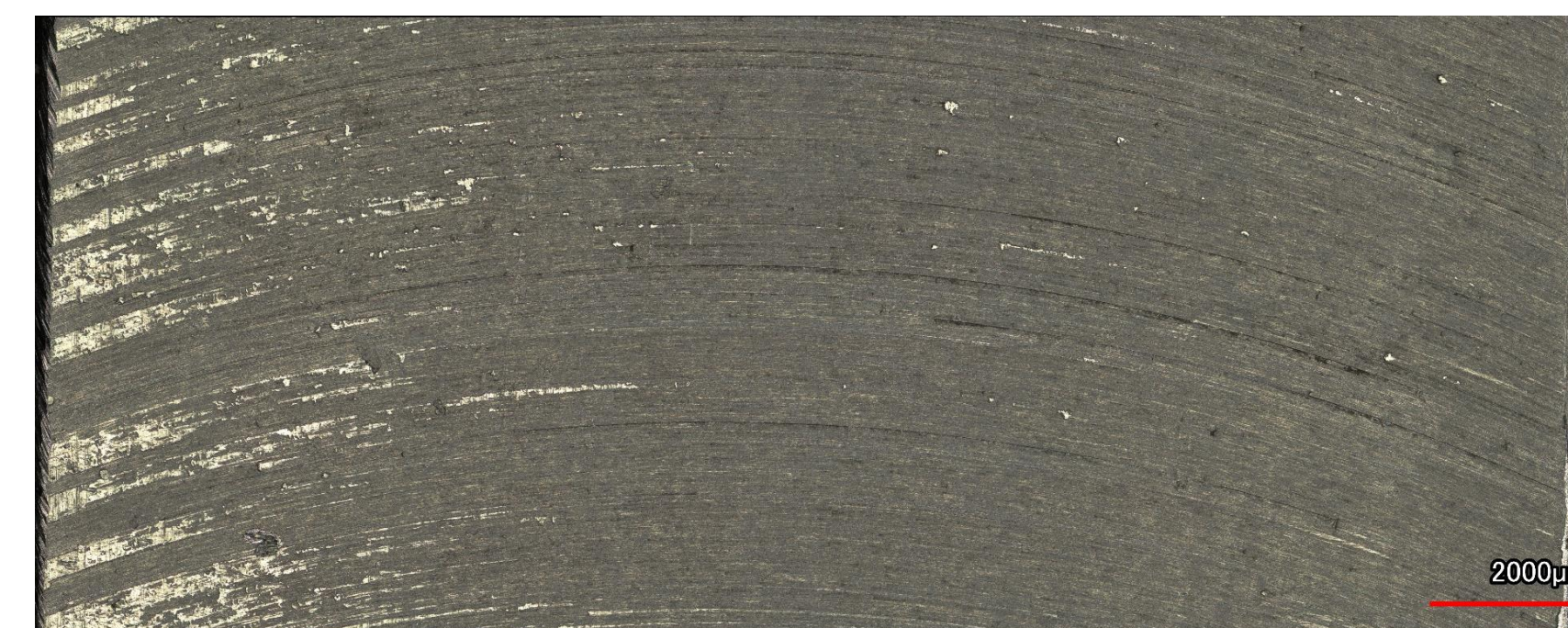


1. Flywheel
2. Minimum Opening Mechanism
3. Stationary Jaw Assembly
4. Moving Jaw Assembly
5. Tension Spring
6. Balancing Wheel

- a. Eccentric Drive Shaft (4140 Steel)
- b. Wear Plate Clamp – Holds wear plates in position
- c. Removable Wear Plates – Test specimens
- d. Toggle Plate – Allows for elliptical movement of jaw
- e. Bronze Bushing – Protects shaft
- f. Bushing Clamp – Holds bushing and jaw on shaft



Wear Test Results



Conclusions

- Initial testing of the apparatus confirmed the presence of gouging abrasion in worn test plates
- The 3.7 kW electric drive motor has enough power to effectively crush rock with the flat wear plates.
- The wear plates had measurable weight loss resulting from gouging abrasion.
- The gouging-abrasion testing apparatus is deemed suitable to examine wear resistance of cryogenically treated materials

Recommendations

- Use higher strength alloy steel for the body such as *Hadfield's manganese steel*. [4]
- Use higher alloyed steel for the wear plate housings, such as maraging steel or other HS steels
- Generate database of a variety of wrought and cryogenically treated materials
- Design user-friendly method of sample extraction, possibly utilizing magnets.
- Create a user manual, complete with SOP and safety information regarding operation.

References

- [1] Cahn, J. (2012), Deep Cryogenic Treatment: A Game Changing Technology
- [2] ASTM G81-97a (2013), Standard Test Method for Jaw Crusher Gouging Abrasion Test, ASTM International, West Conshohocken, PA, 2013, www.astm.org
- [3] Hawk, J.A. (1997), Laboratory abrasive wear tests: investigation of test methods and alloy correlation, *Wear*, Vol. 225-229
- [4] Smith, W.F. (1981), *Structure and Properties of Engineering Alloys*, New York: McGraw-Hill Book Company, 1981