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Understanding the effects of tooth brushing using an abrasive dentifrice on the wear of enamel

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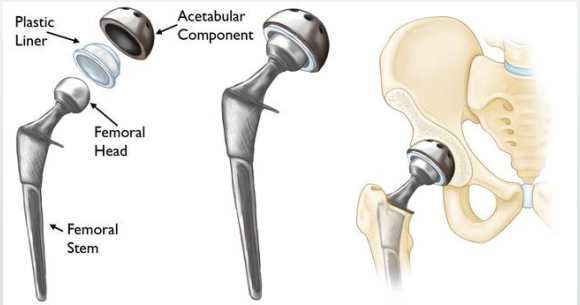
What is Tribology?

- The study of friction, wear and lubrication.
- The science of interacting surfaces in relative motion.
- The UK economy loses £24billion every year because of problems with friction, wear and lubrication.
- Tribology looks at ways of reducing this damage in transport, manufacturing and healthcare sciences.



Introduction

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- Most common method to clean teeth is using a toothbrush with a dentifrice
- Toothpastes contain abrasive particles that are harmful to the delicate tissues of the teeth
- During tooth brushing, these hard particles can cause the tooth surface to wear

Previous studies

- Dentine wear (1,2)
- Reciprocating rig
- Calcite and perlite abrasive particles (3)

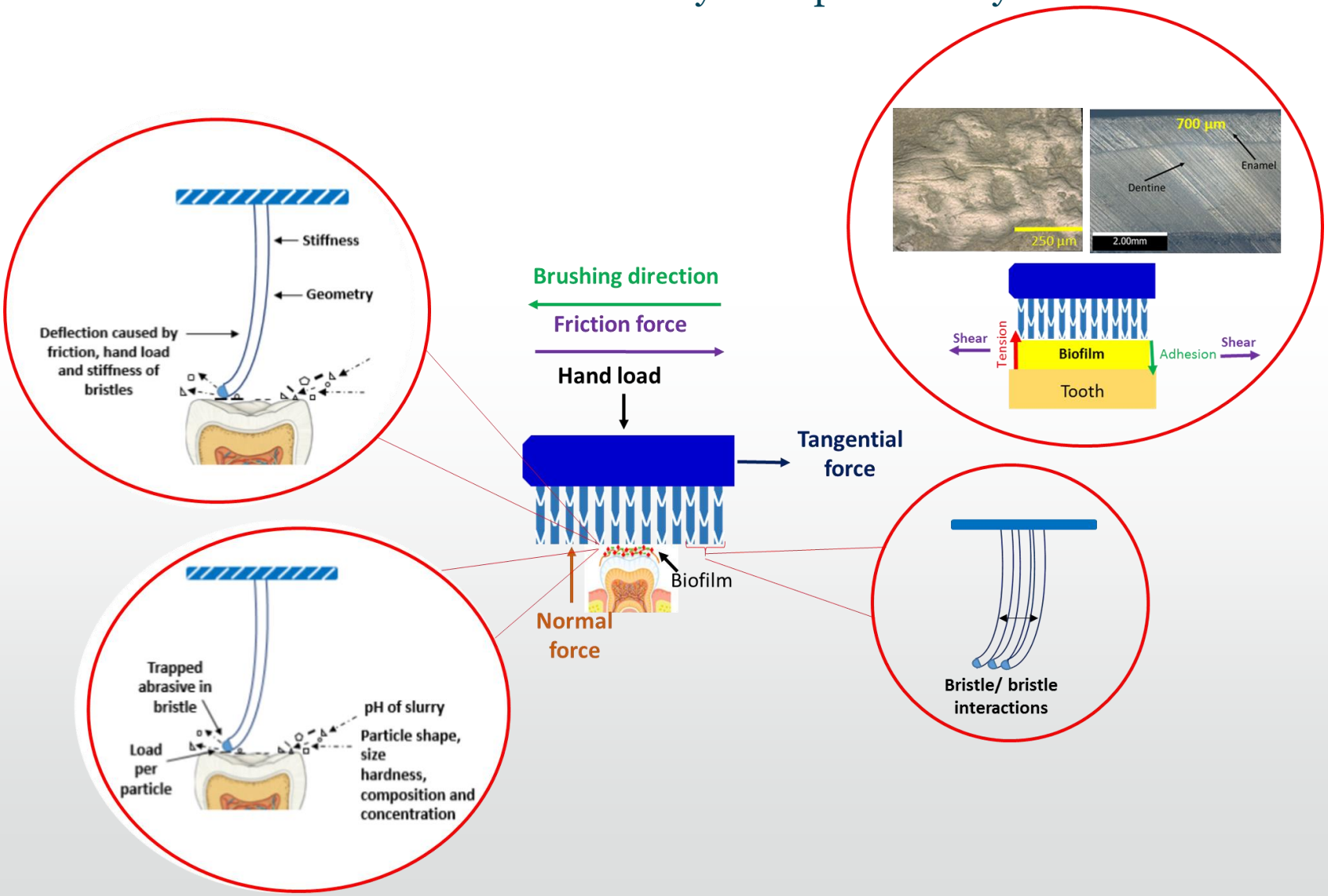
Proposed study

- Enamel wear
- Novel head design of rig
- Alumina and silica abrasive particles

1.Addy, M., Tooth Brushing, Tooth Wear and Dentine Hypersensitivity - Are They Associated? Journal of the Irish Dental Association, 2006. 51(5): p. 226 -231.
2.Ganss, C., et al., Effects of Toothbrushing on Eroded Dentine. European Journal of Oral Sciences, 2007. 115: p. 390 - 396.
3.Lewis, R., S.C. Barber, and R.S. Dwyer-Joyce, Particle Motion and Stain Removal During Simulated Abrasive Tooth Cleaning. Wear, 2007. 263: p. 188 - 197.

Aim

Obtain an understanding of the tribology behind the interface of the tooth and toothbrush lubricated by toothpaste slurry



Methodology

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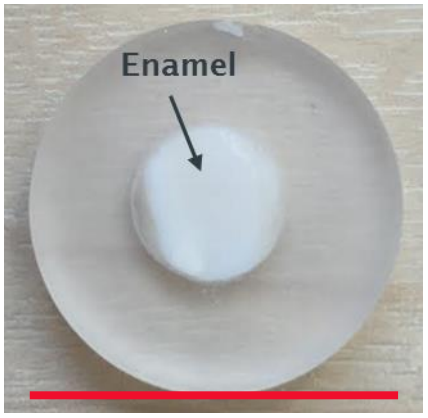
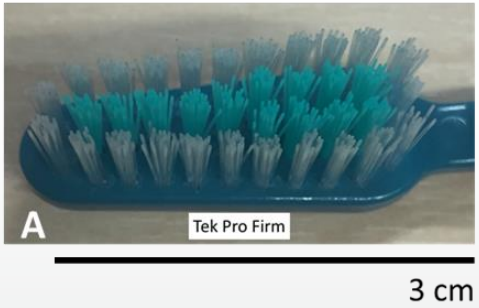
Test Materials

- Bovine teeth
- GSK mounted in epoxy resin
- Polished
- Hydrated



Toothbrush

- Tek Pro® firm
- Bristle diameter – 110 µm



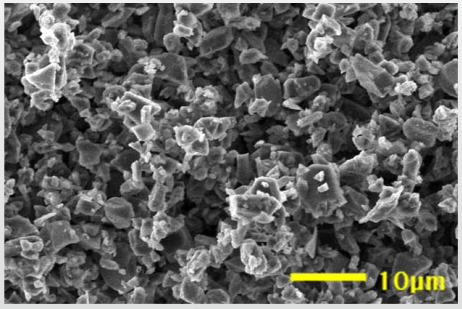
Angular abrasive particles

- **Alumina** (HV = 2500)

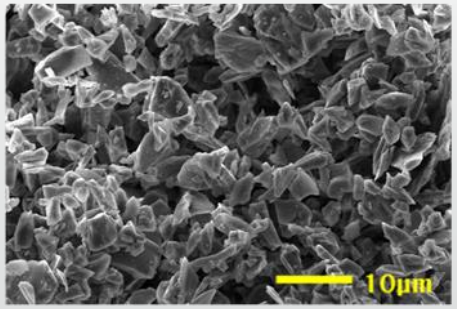
Mean particle size alumina - 9µm

- **Silica** (HV = 1200)

Mean particle size silica – 19µm



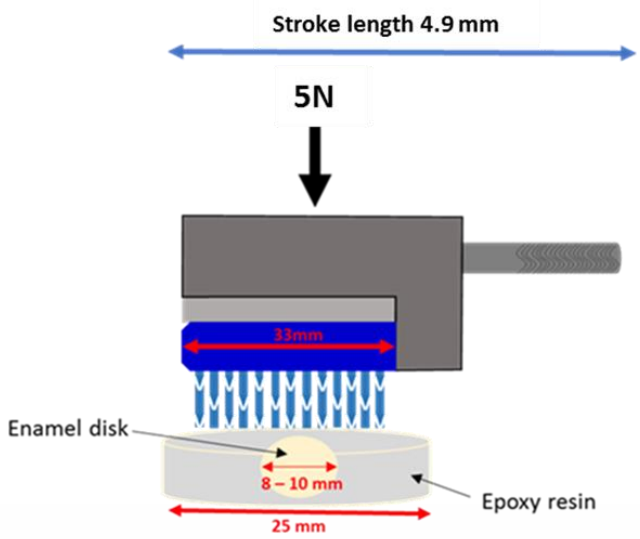
Alumina

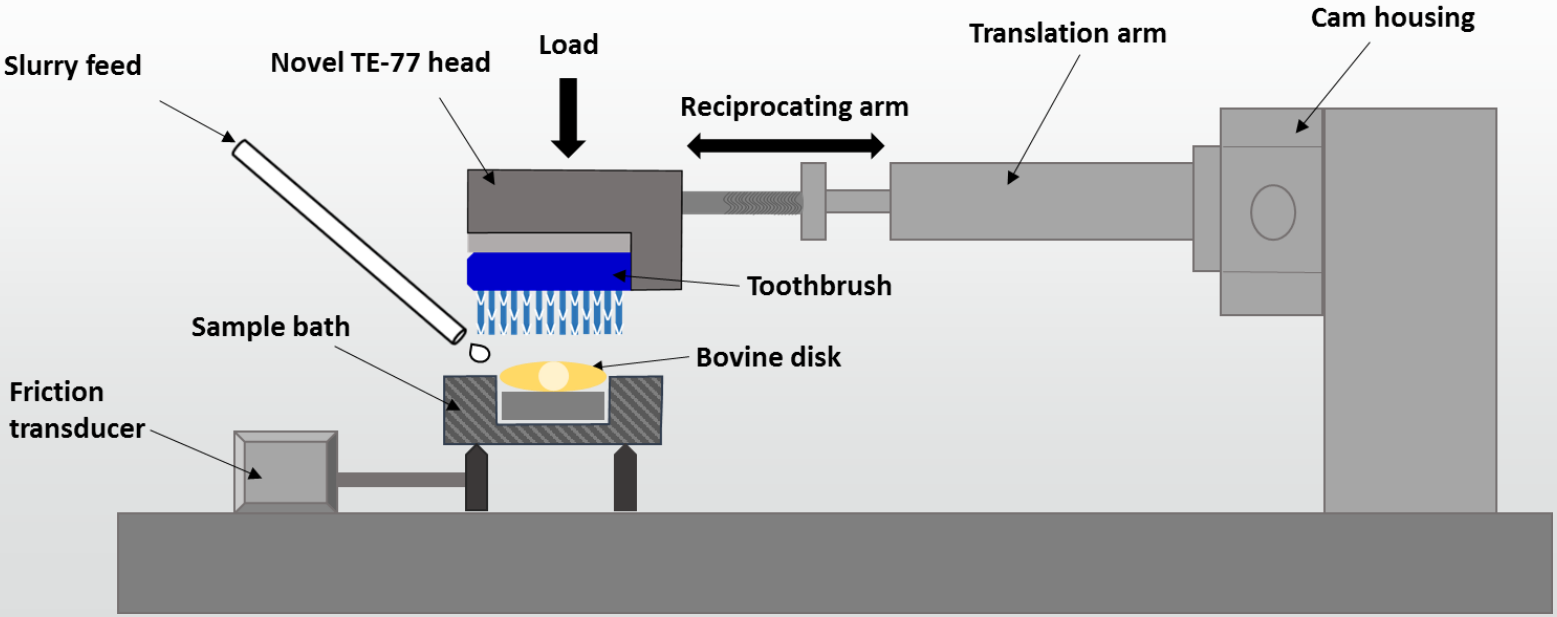


Silica

Reciprocating rig

Test conditions	Quantities
Load (N)	5
Frequency (Hertz)	4
Stroke length (mm)	4.9
Slurry concentration (g/cm^3) BS EN ISO 11609:2010 Dentistry — Dentifrices — Requirements, test methods and marking	0.5% CMC + 10% Glycerine (base) + 20% abrasive
Counterface material	Enamel disk





Friction results

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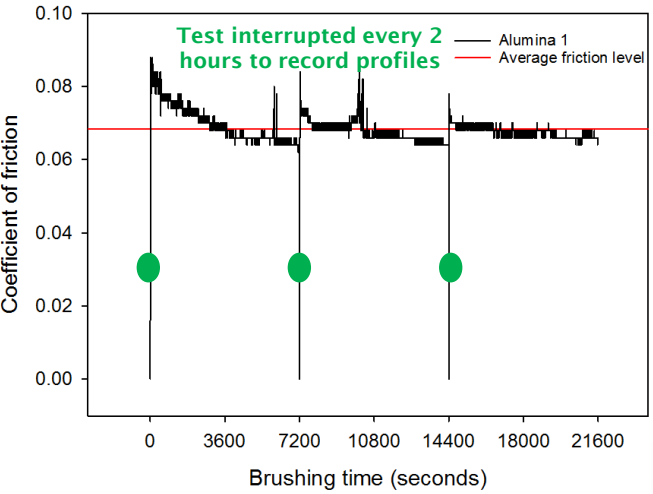
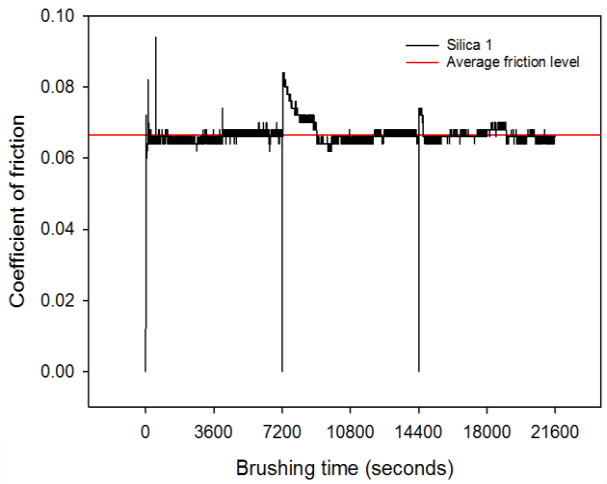
Alumina



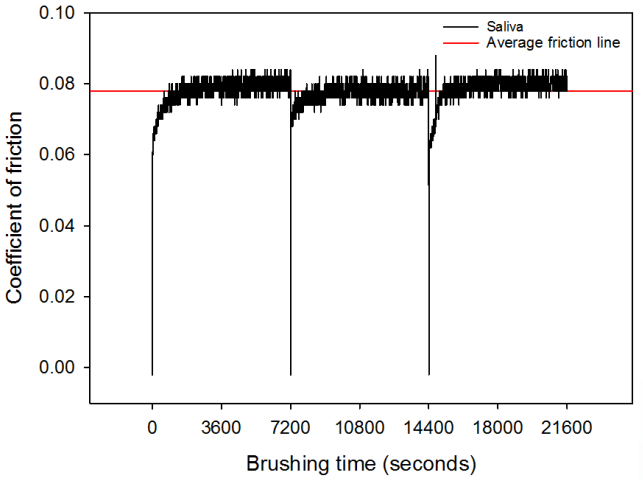
Mean friction = 0.071
stdev ±0.0054

Silica



Mean friction = 0.066
stdev ±0.0030

Saliva



Mean friction = 0.078
stdev ±0.0042

- Nylon alone cannot damage enamel
- Particles embedded on the nylon bristle roughen the enamel.
- Friction between wet nylon and enamel = high
- Friction between particle and enamel = low

Talysurf profiles

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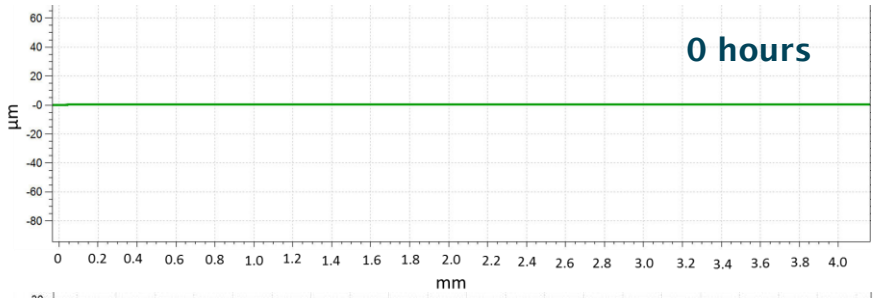
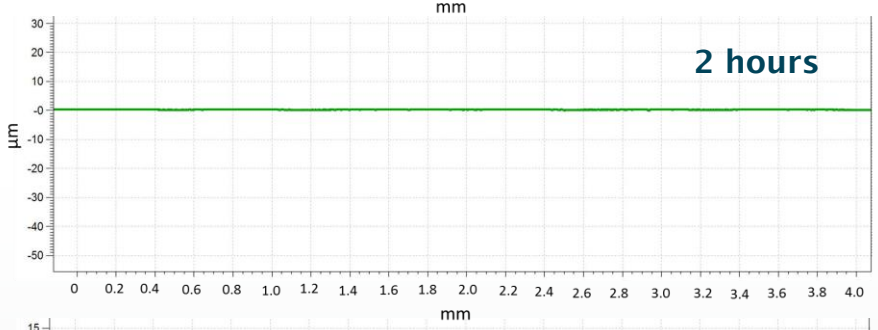
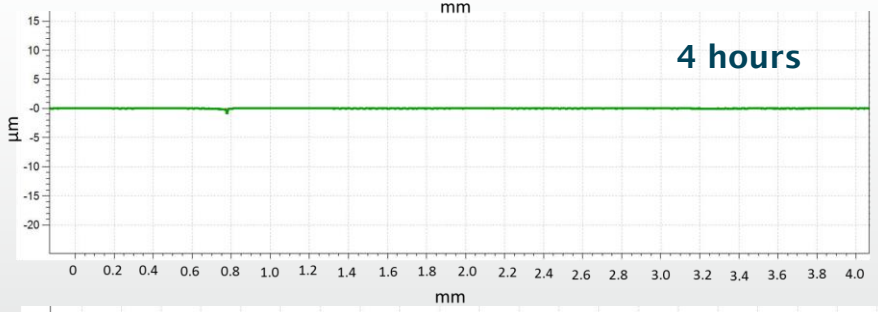
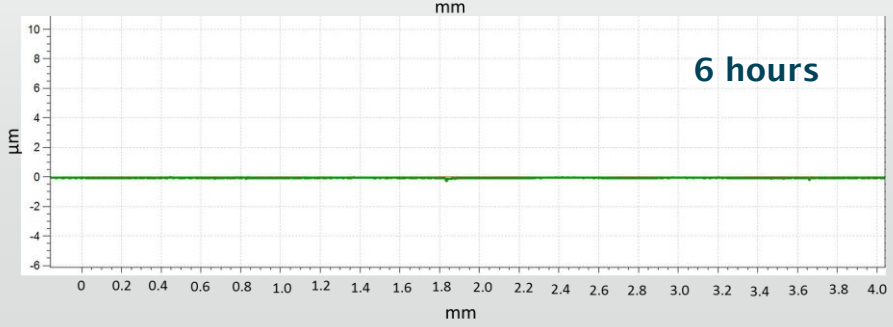
Saliva

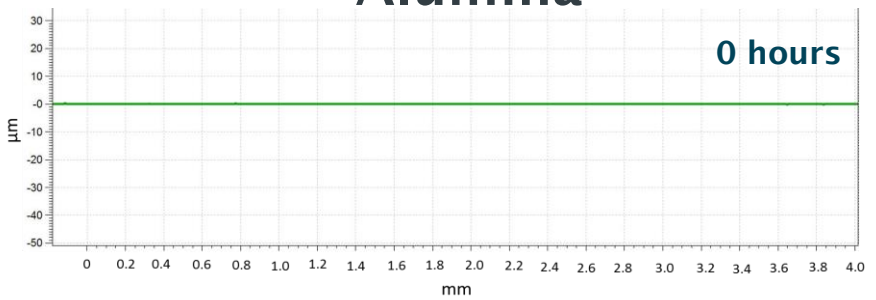


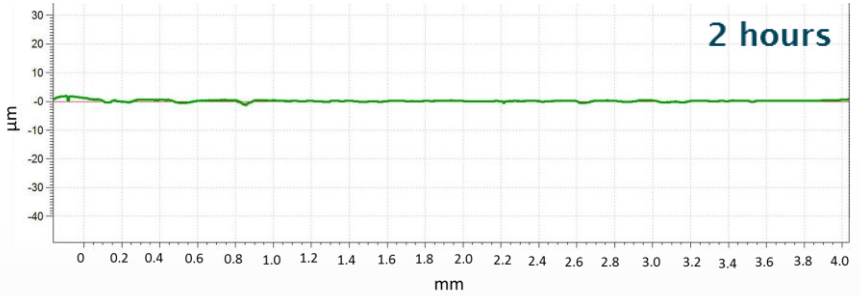


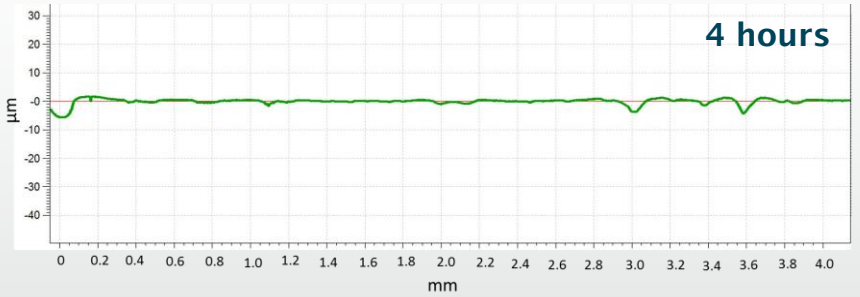


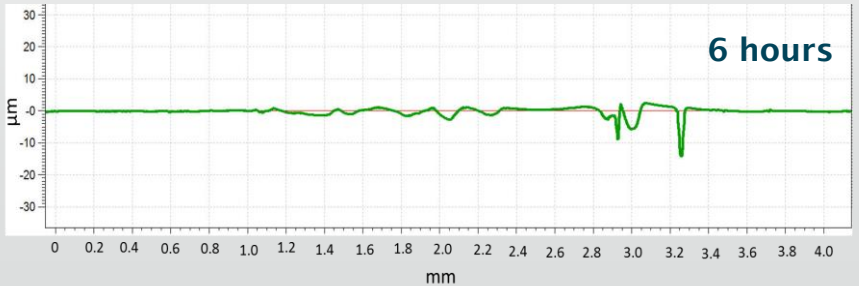


Alumina









Wear process

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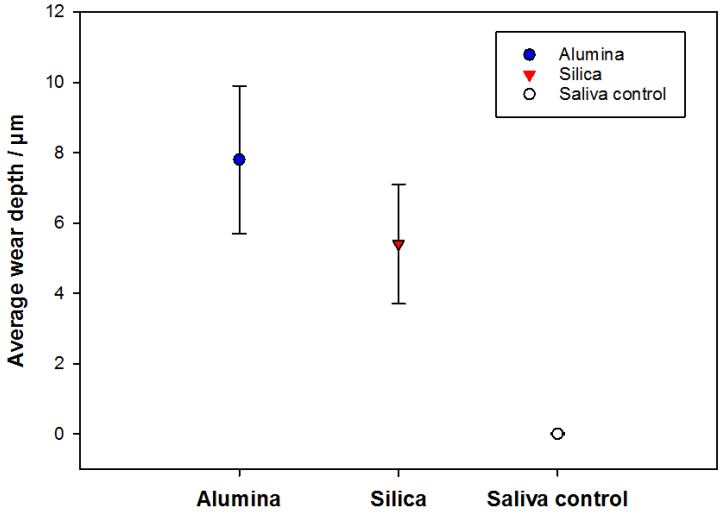
Stage 1

2 - body grooving

Material removal

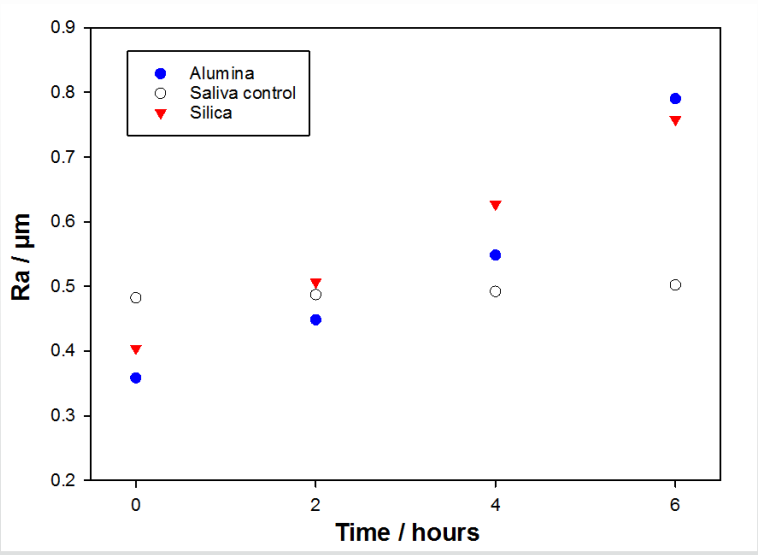
V1 = wear volume



Stage 2

Overall roughening effect

Increase in roughness



Bovine disk: Wear analysis

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1. Particle pressed against enamel by the deflected bristle

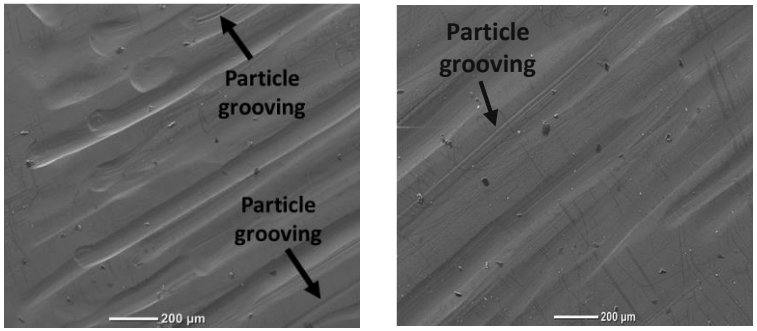
2. Loaded particle acts in a 2-body way

3. Bristles with entrained abrasives are causing 2-body abrasion

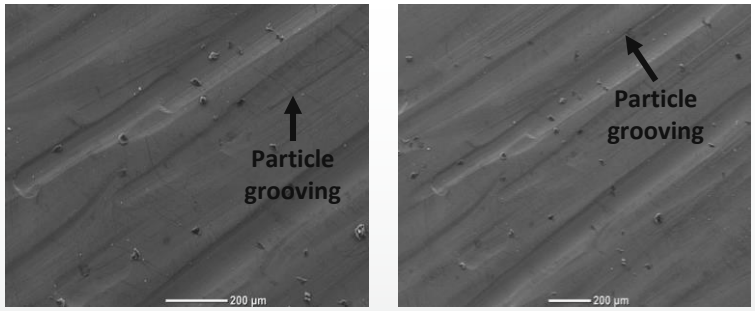
- Large grooves = bristles
- Smaller grooves = individual particles

4. Results in a rough surface and change of profile

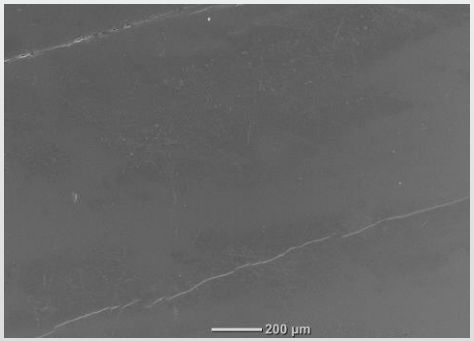
Alumina



Silica

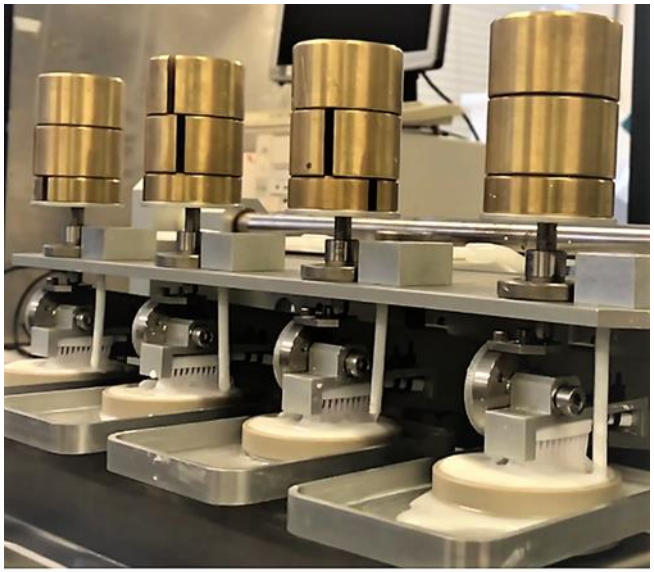


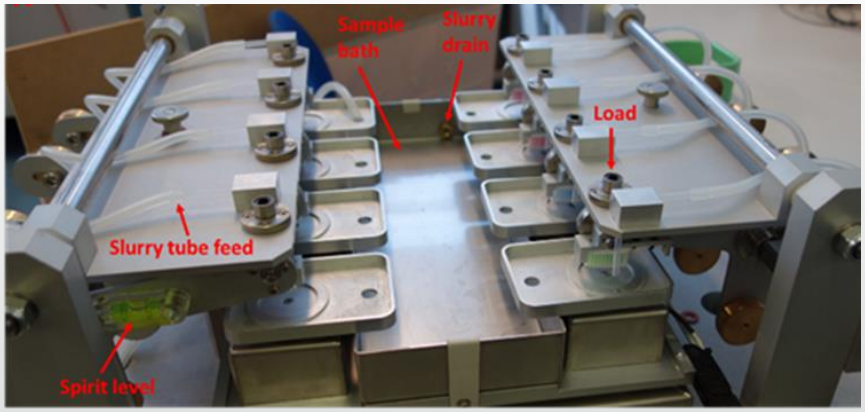
Saliva



Summary

- Alumina generates more wear on enamel compared to silica
- Both particles roughen the teeth overtime
- A significant difference in friction between the particle and control slurry group
- Future work will explore lower loads of 1N and 2N on the multi-station rig





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