KERONITE
ADVANCED SURFACE TECHNOLOGY

Surface Hardening for Mechanical Applications of Magnesium

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Overview

- Why magnesium?
- Magnesium Corrosion and wear
- Background - Keronite PEO process
- Some characteristics and recent results
- Process Capability
- Summary

Why Magnesium?

- **Magnesium-base alloys are of growing interest for many industrial applications**
  - **Favourable strength to weight ratio**
  - **Thin walls and high casting rates**
  - **Good mechanical and physical properties / excellent castability**
- **Mass reduction improves fuel economy**
  - **Especially reduction of moving masses e.g. pistons, gears, connecting rods, wheels which also improves responsiveness of the engine, pump, actuator, motor, transmission, vehicle etc**
- **But the relative poor corrosion and wear resistance limits its industrial use for a number of applications**

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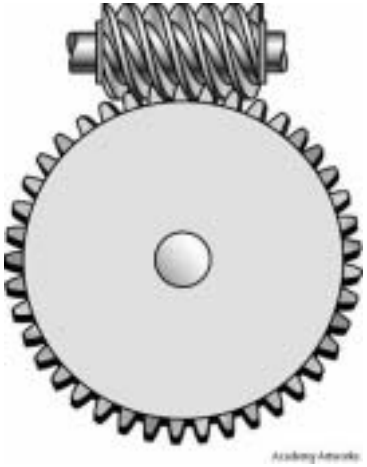
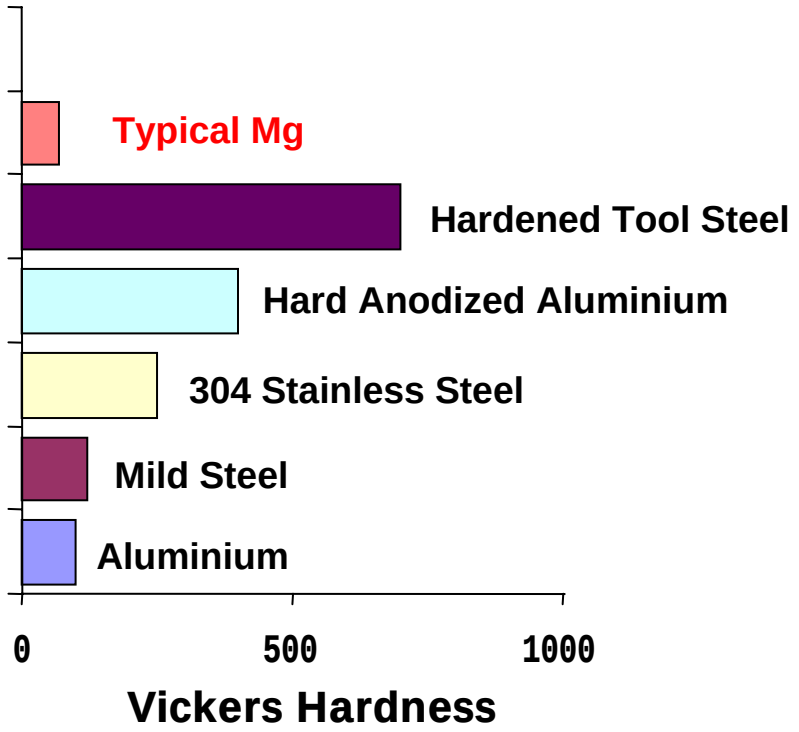


Magnesium Corrosion

- **Salt spray corrosion: 1000 hours ASTM B117 test**
  - **Area corrosion – less than 1% (rating 9 or above according to ASTM D1654)**
  - **Corrosion creep from scribe – less than 0.5 mm (rating 9 or above according to ASTM D1654)**
  - **Galvanic corrosion (*with top coat*) – less than 1% (rating 9 or above according to ASTM D1654)**

Magnesium Wear

- **Magnesium is a good choice because of its favourable strength to weight ratio**
- **Requires thixomolded or forged parts for structural integrity**
- **However, surface hardness circa 60 – 100HV means Mg is easily worn by common counterpart materials – steel, cast Al-Si-Cu alloys, ceramic, nitride etc**



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What is Keronite?

- **Advanced surface treatment for light metal alloys (e.g. Al, Mg, Ti) to provide superior hardness, corrosion, wear, thermal resistance and other functional and optical properties.**
- **Keronite® - Worldwide patented plasma electrolytic oxidation (PEO) process.**
- **Commercially available technology**
- **Industrially scalable**
- **Environmentally safe process**

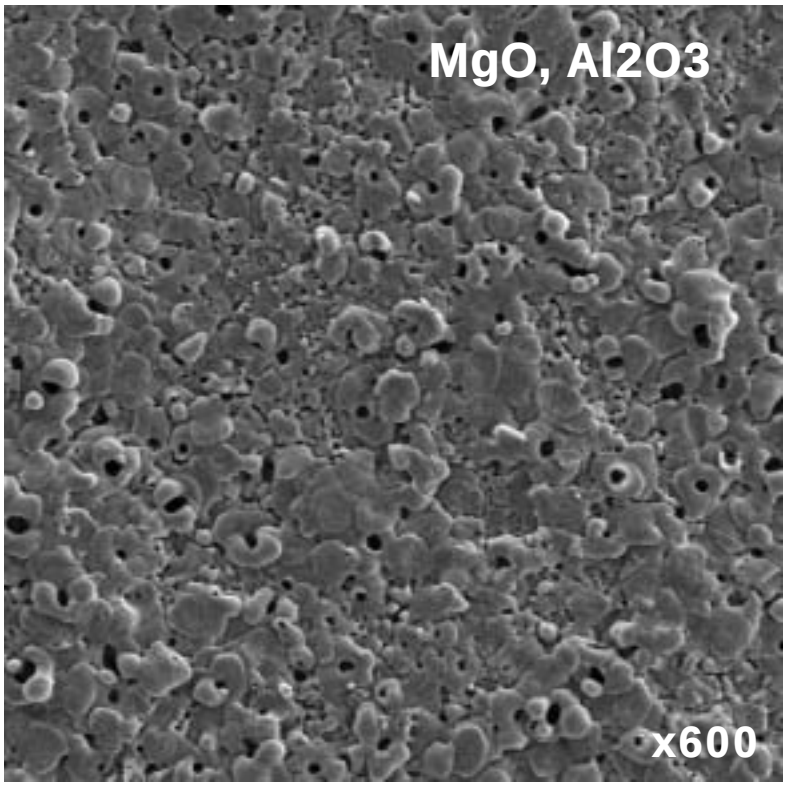
What is Keronite?

- **Keronite is a surface treatment process for light metals and their alloys by plasma electrolytic oxidation by bipolar electrical pulses.**

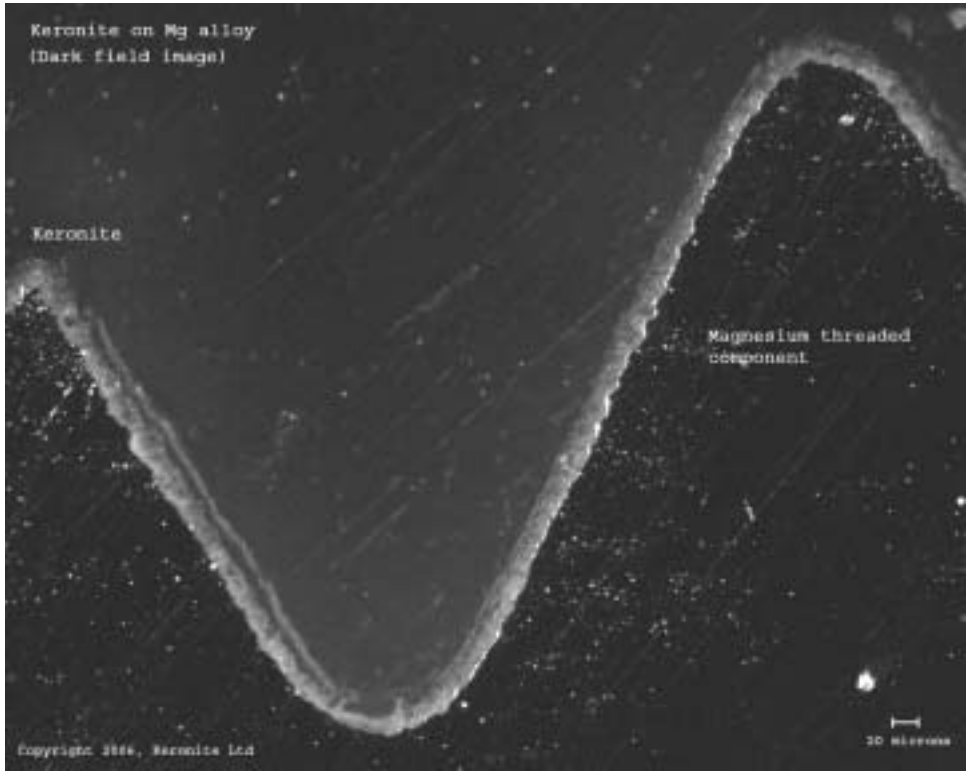
- **Keronite ceramic surface is produced by transforming the substrate metal surface into hard, dense and highly adherent oxide layer by plasma discharge in a low concentration alkaline aqueous electrolyte.**

Plasma discharge in the electrolyte bath

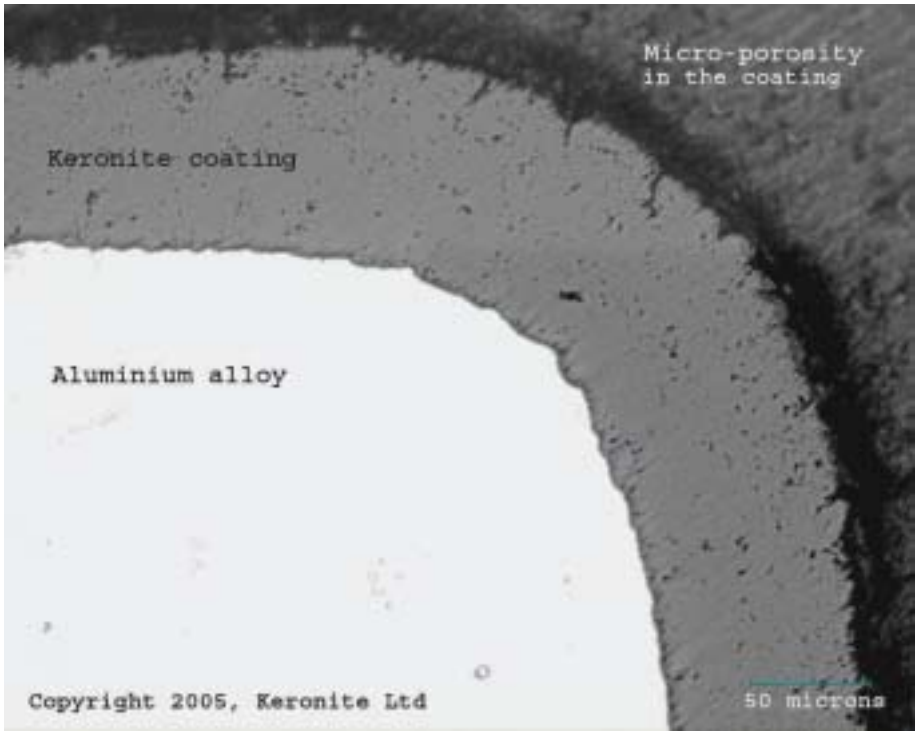
Coating Microstructure



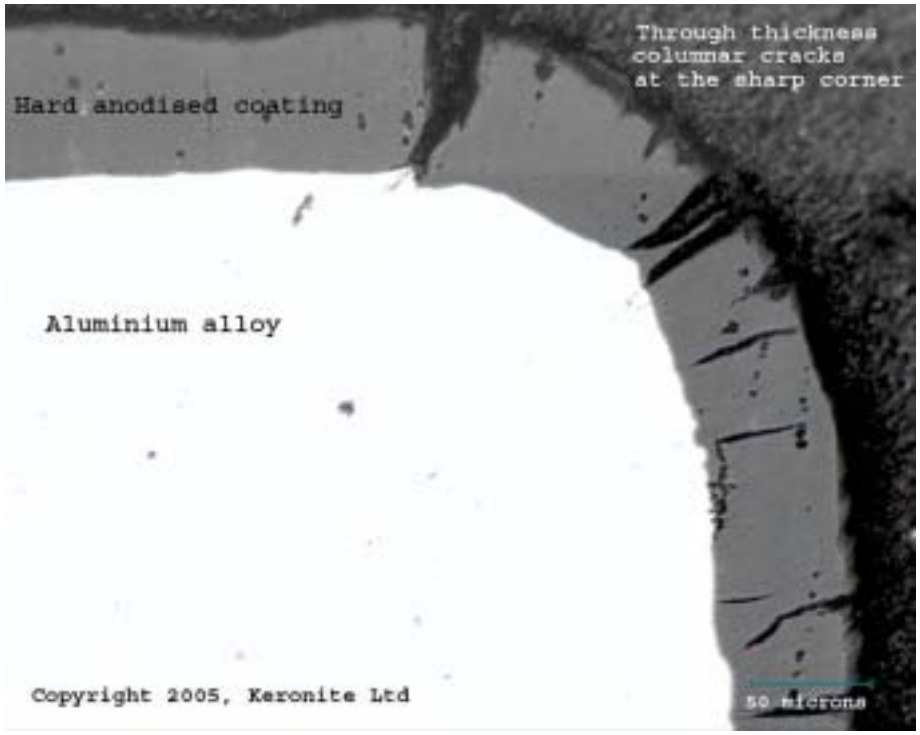
AZ91 alloy



Integrity at corners / edges



Keronite coating



Hard anodised coating

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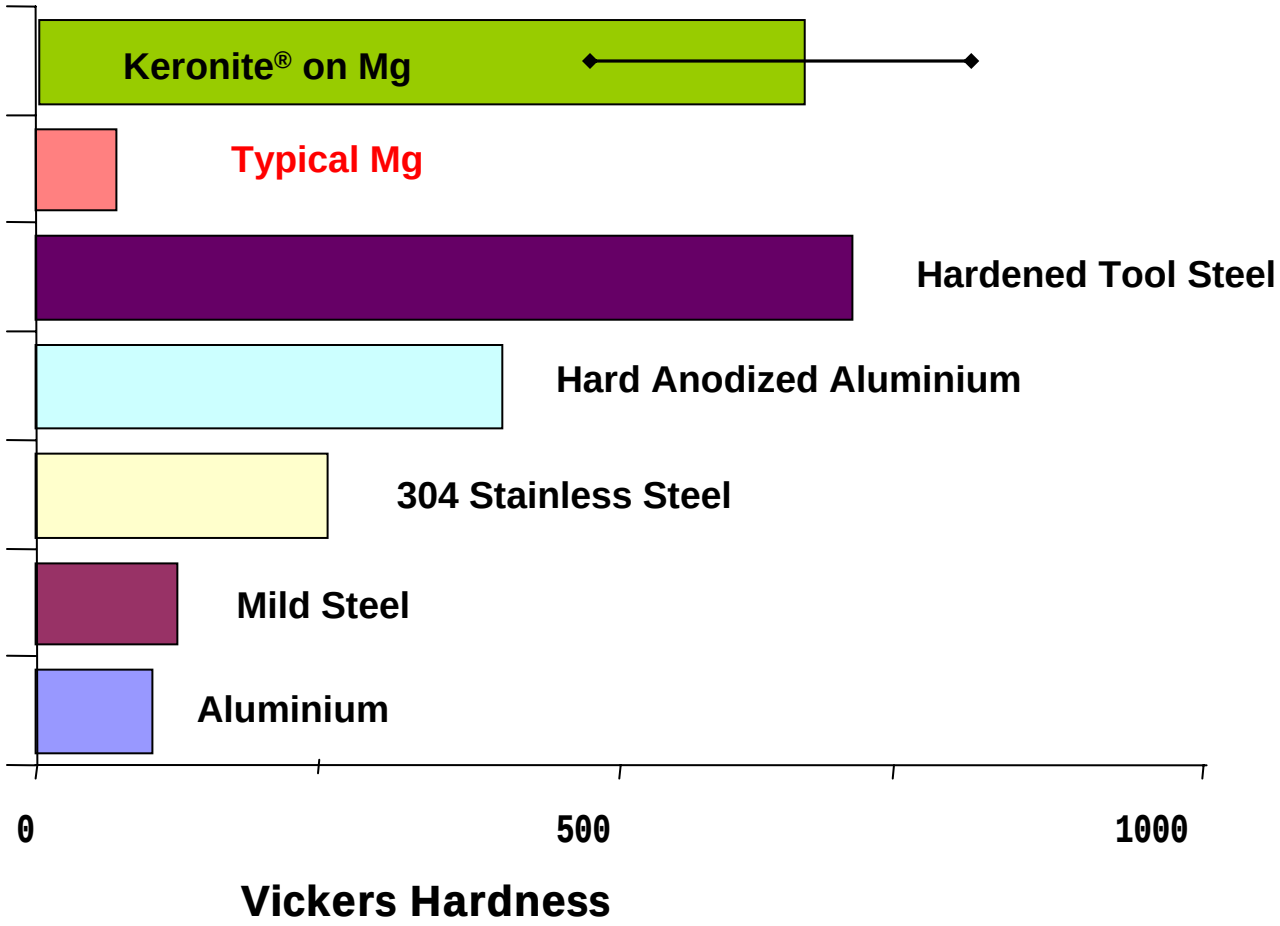
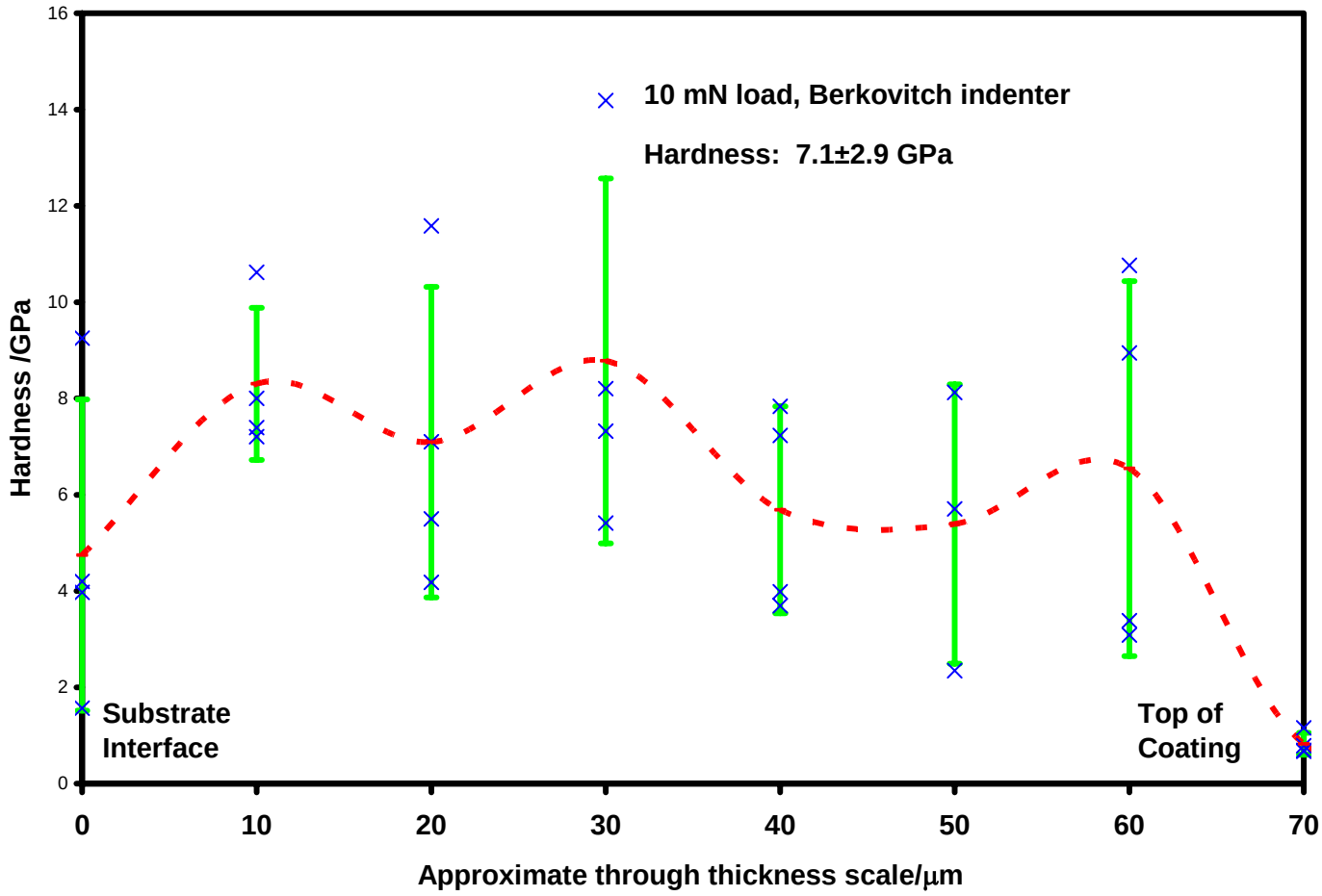
Coating Hardness



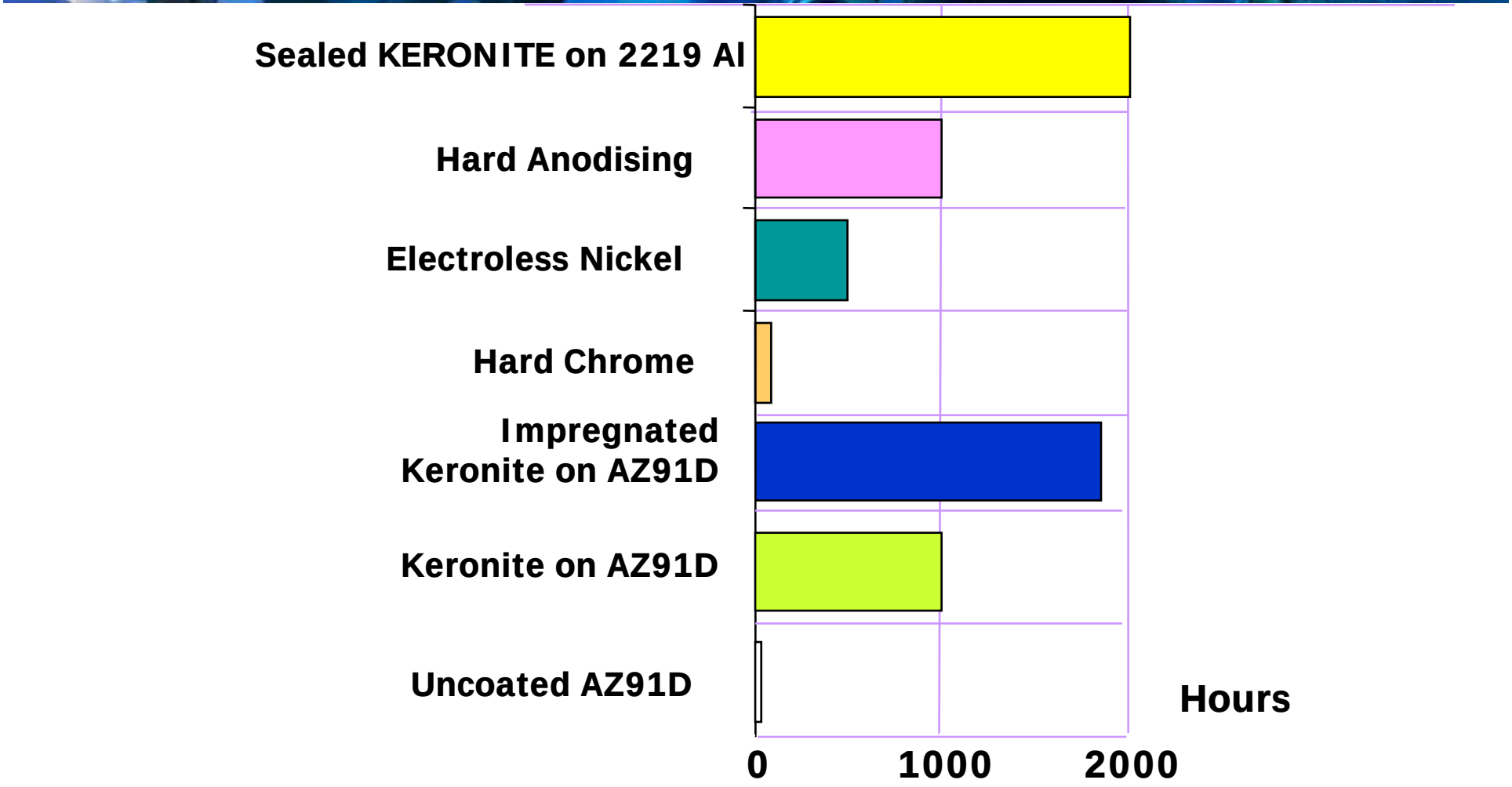
Coating Hardness

Courtesy of University of Cambridge

Alloy AZ91



Salt Spray Endurance

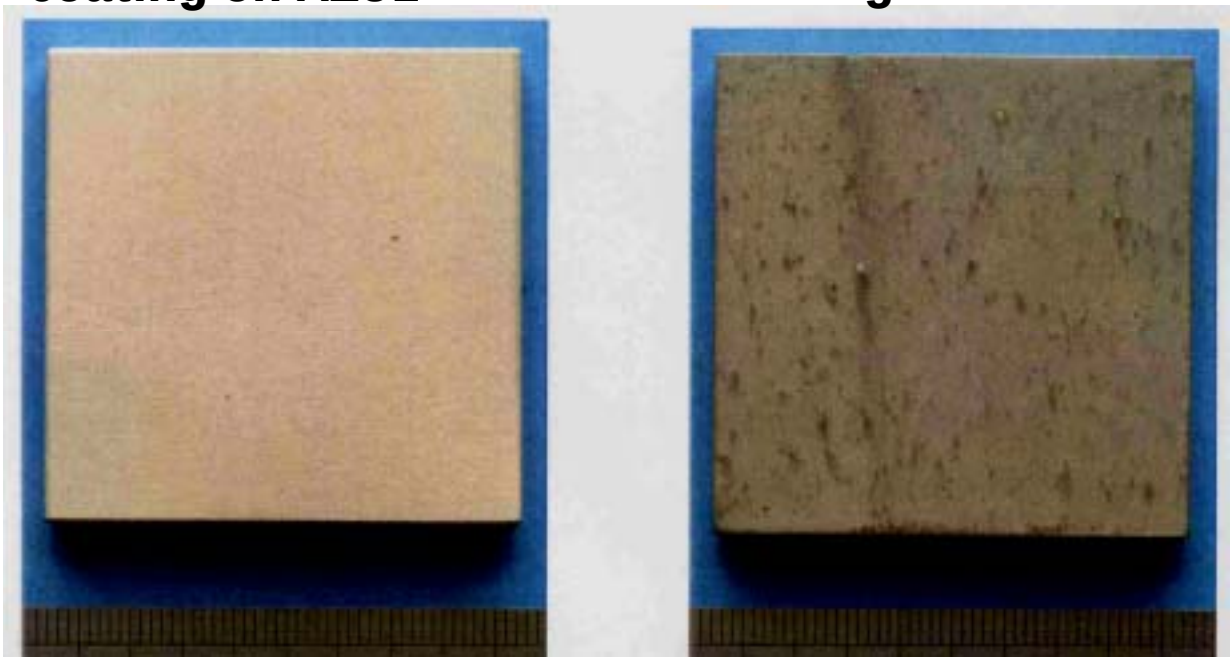


Environmental Exposure

- 10 cycles of thermal shock (-196 and +100°C) followed by
- 336 hours of salt spray exposure to ASTM B117

10μm Keronite coating on AZ31

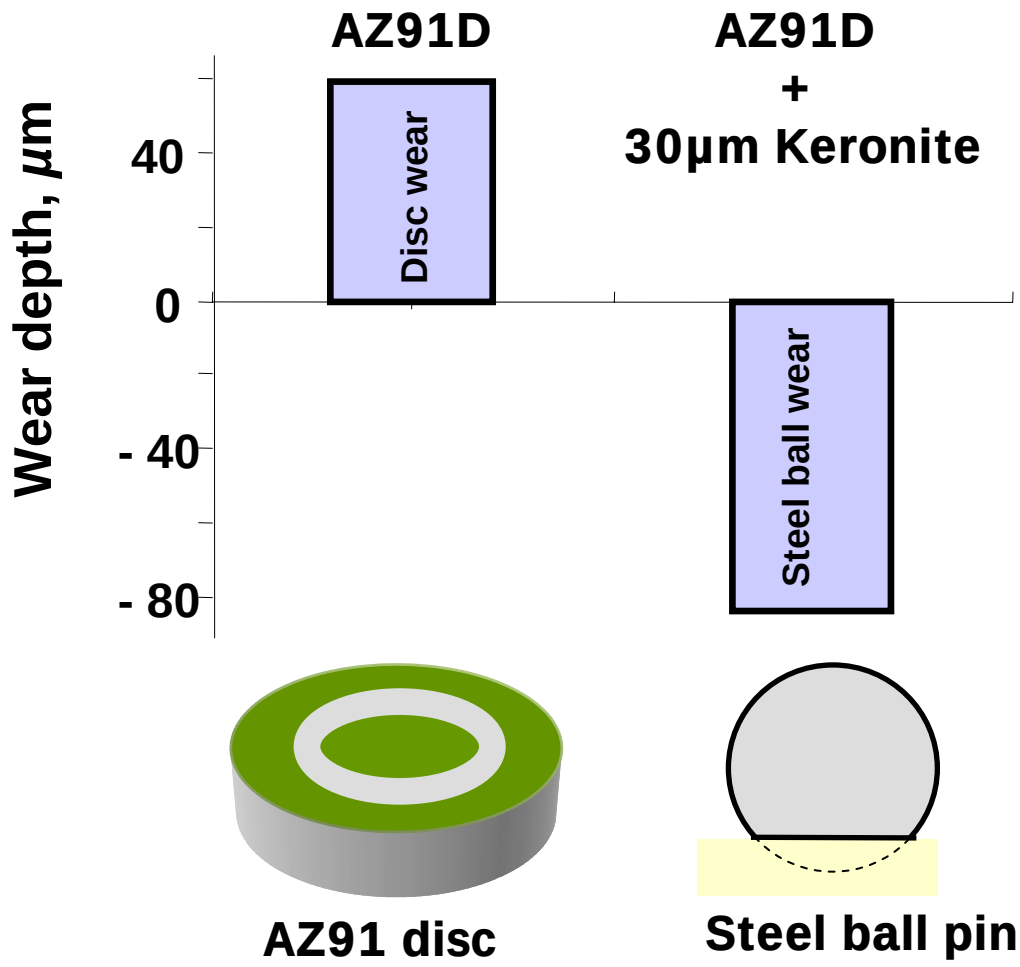
10μm Anodised coating on AZ31



Courtesy: TWI Ltd

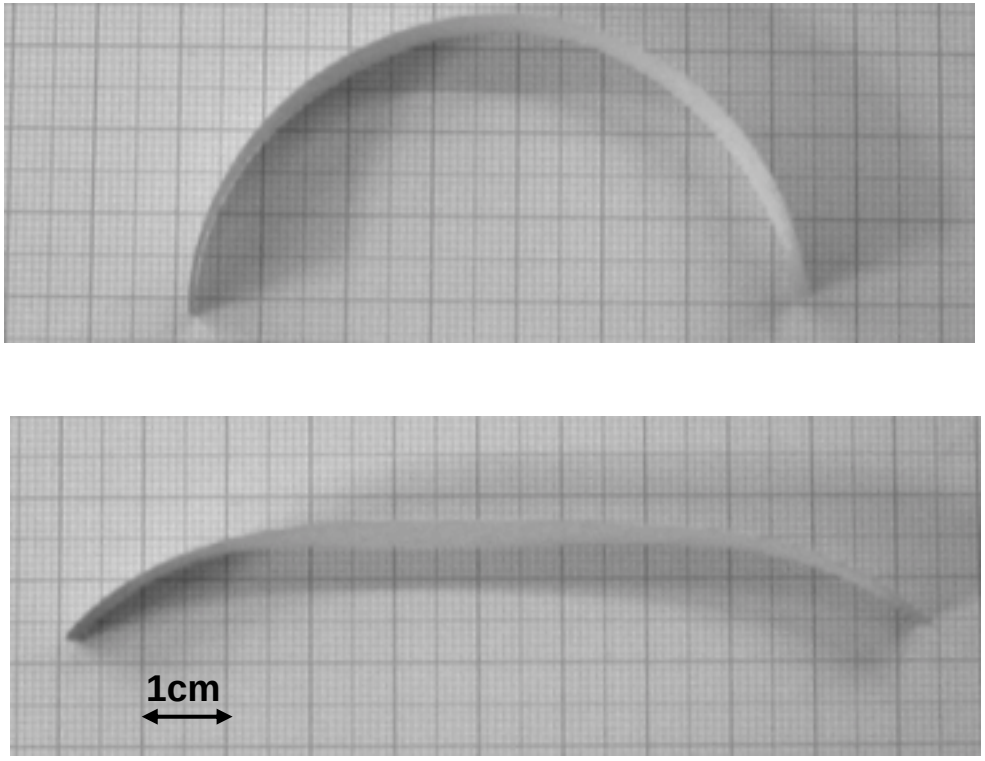
Pin-on-Disc Wear ASTM G99

- 10N load
- 10mm diameter AISI 52100 bearing steel ball
- 0.1 ms^{-1}
- 5000s



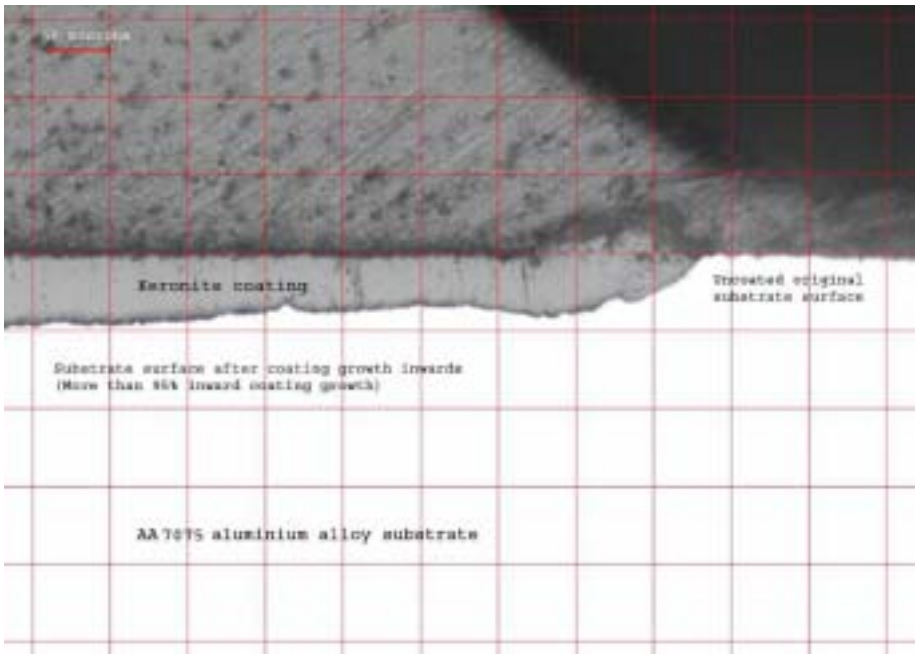
Coating Flexibility

- **100µm detached Keronite film showing ability to be bent or flattened elastically.**
- **In more severe deformation, both plastic and elastic deformation occurs.**
- **Up to 100% strain before failure.**

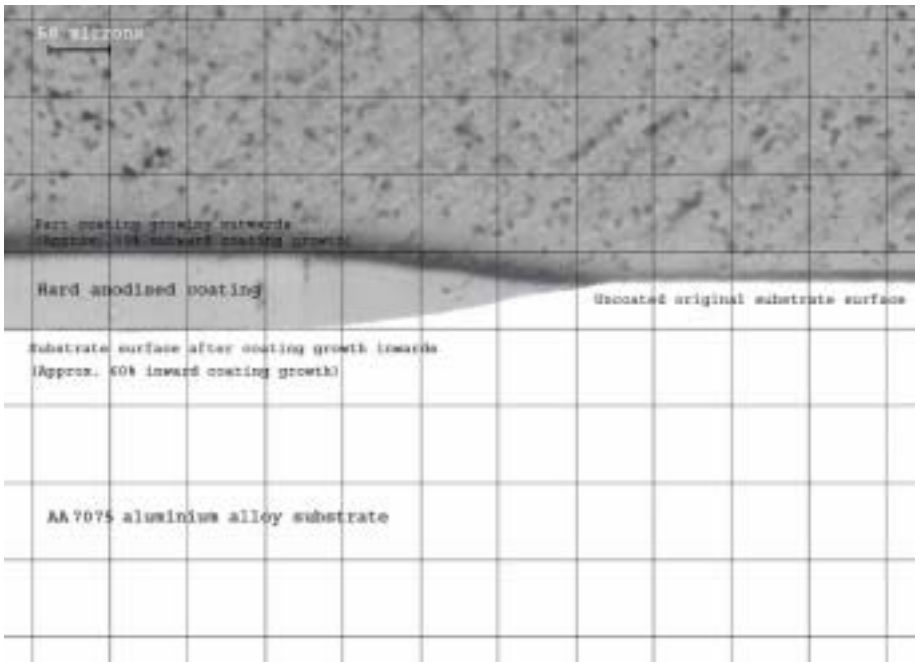


Courtesy of Cambridge University

Coating Growth Mechanism



Keronite

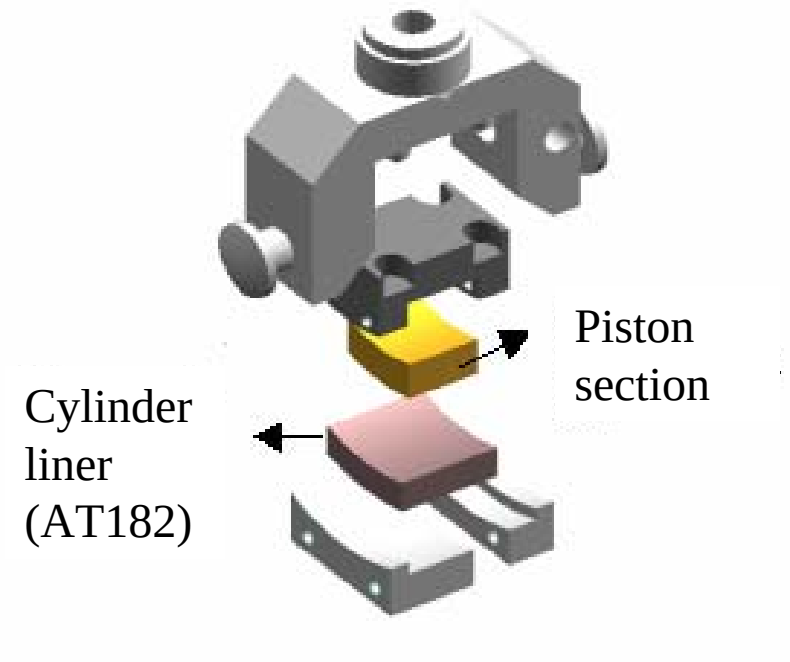


Hard anodised

EU Nanomag project

BACKGROUND

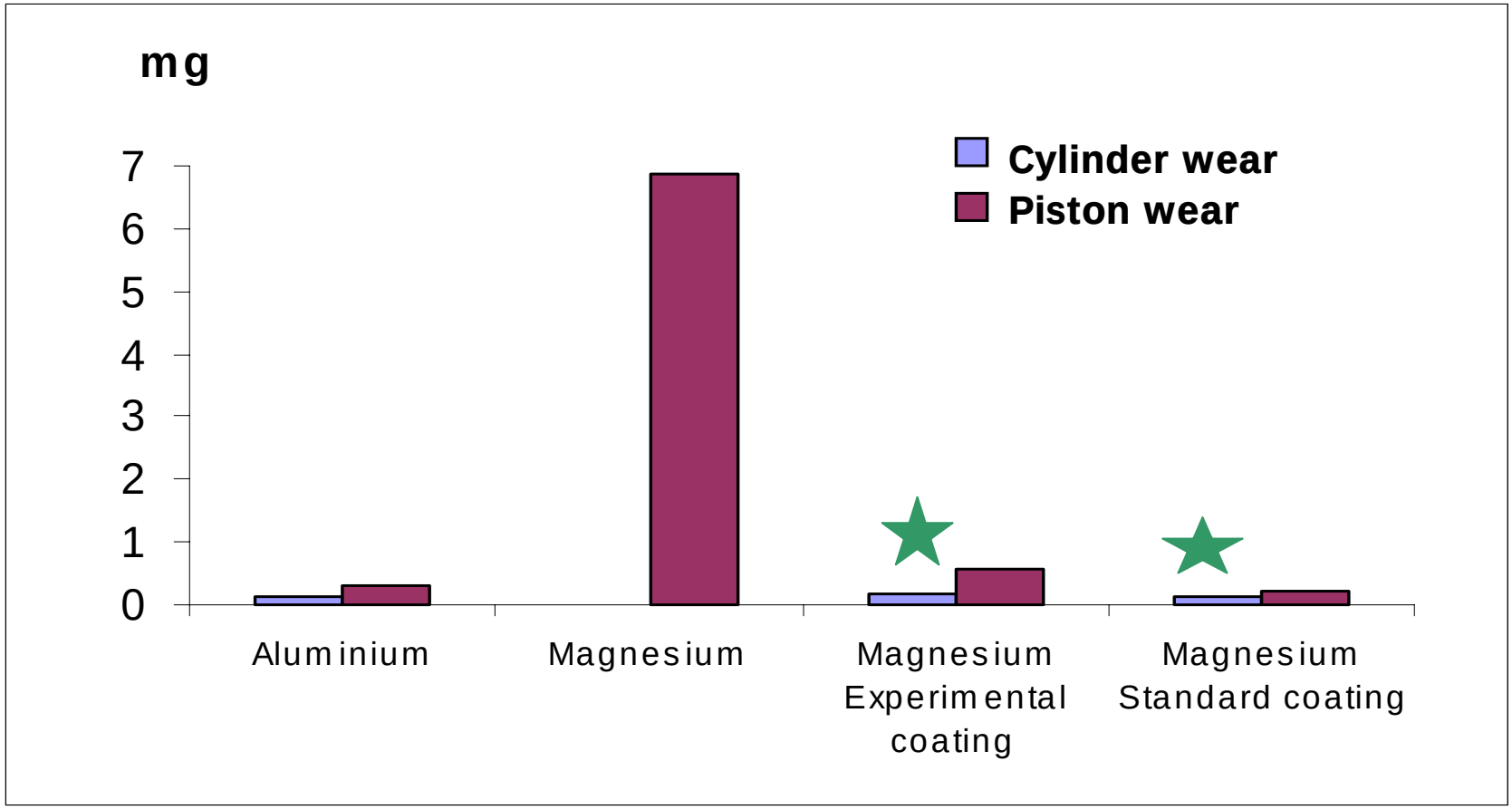
- **3yr study into environmentally-friendly coatings for Mg anti-corrosion and wear in the transport industry**
- **Included tribology study of cast aluminium c.f. Mg + Keronite**
- **4 different types of tests (pin-on-disk, ball-on-disk, sliding wear of piston, rotating wear of piston pin) conducted to verify the tribological behaviour of Keronited Mg.**



Load:100N; Frequency: 20Hz; Stroke: 3mm; Time: 30 minutes; Temperature: 150°C

Oil: Repsol 15w40

Nanomag Tribology Results



EU Nanomag project
Mg tribology study

CONCLUSIONS

- Mg easily worn by most counterparts
- Magnesium coated with Keronite presents very good tribological properties.
- For two interfacing Mg surfaces, both surfaces should be covered with Keronite to produce minimal wear.
- The behaviour of the coated magnesium is similar to that of uncoated cast aluminium.

Pistons

- **Keronite prevents skirt wear and pin-hole wear.**
- **Under investigation in Japan, Europe and USA**

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Automated Keronite Line

Overhead Transporter

- **Real time view of overhead transporter moving flight bar with components through the Keronite line.**
- **Two independent transporters enable required line productivity.**

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Summary