

KERONITE – NEW SURFACE TREATMENT TECHNOLOGY FOR LIGHT METALS

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Scientists at Keronite have developed a unique form of surface treatment for light alloys such as aluminium and magnesium. Known as Plasma Electrolytic Oxidation (PEO), the patented Keronite process converts the surface of these substrate alloys into a dense, hard ceramic oxide which is extremely resistant both to corrosion and wear. Keronite has its own manufacturing facilities for process plant and electrolyte solutions. Established in 2000 with headquarters in Cambridge, UK, Keronite International Ltd continues to develop new technology in the surface finishing of light metals.

THE KERONITE PROCESS

The process itself as it uses similar processing tanks and jiggling systems to those used in anodising. However, the Keronite technology is quite different from anything ever seen before. For one thing, the low concentrate alkaline electrolyte solutions used in the Keronite bath contain no chrome or other heavy metals, no ammonia, no acids, and the process generates no hazardous waste. As an immersion process with excellent throwing power, Keronite can be used to treat the inner surfaces of cavities with restricted access or parts with complex geometries, unlike line of sight processes such as plasma sprayed ceramic or powdercoating.

The power supply is also quite different from that of any conventional surface treatment process. Keronite uses a sophisticated pulsed alternating current to create plasma discharge sparks on the surface of the substrate and it is this localised plasma discharge that fuses the oxides of the alloying elements to form a protective layer of ceramic. Self-regulating, the Keronite ceramic “grows” above and below the surface of the substrate to form a layer of uniform thickness, although this can be adjusted where necessary through the strategic positioning of counter electrodes. Because the bond with the substrate is at the molecular level, adhesion is not an issue and there is no risk of peeling or cracking.

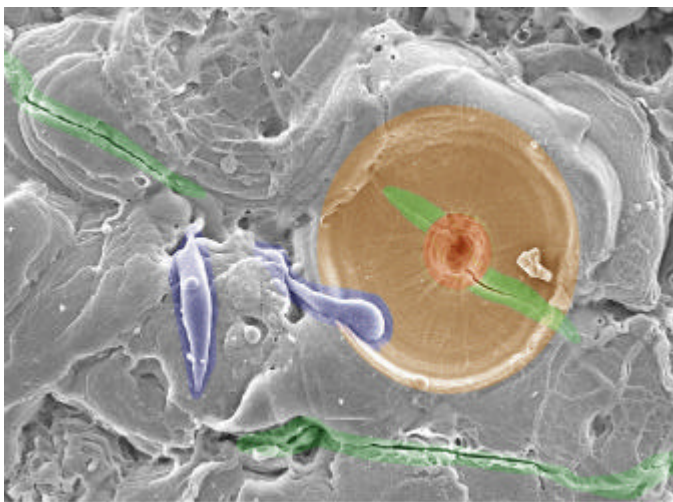
Another advantage that the Keronite process has over conventional anodising is that it can be used to treat a much wider range of alloys, even those containing a low percentage of silicon or other low cost aluminium alloys which are easier and cheaper to machine but which cannot be anodised. Alloys containing a high percentage of copper, iron etc traditionally difficult to anodise present no problem for the Keronite process. The properties of the Keronite ceramic layer will vary from alloy to alloy, as will the colour of the coating, but all can be treated to give improved performance.

Aluminium alloy	Microhardness Keronite HV 100g
2024,2014 (Al-Cu-Mg)	1400 - 2000
6061,6463 (Al-Mg-Si)	1300 - 1800
5056, 3003 (Al-Mg, Al-Mg-Zn)	1200 - 1500
7075, 7175 (Al-Zn-Mg)	1200 - 1600
A.319.0, A.305.0 (Al-Si-Cu)	800 - 1200

THE KERONITE LAYER

A very dense coating with a nanoscale microstructure, Keronite on aluminium has all the performance characteristics of alpha and gamma phase alumina. It demonstrates extraordinary qualities in terms of wear and corrosion resistance as well as acting as an effective thermal barrier in a variety of applications. X-ray analysis of Keronite on magnesium shows that the main constituent of the Keronite layer is spinel ($MgAl_2O_3$).

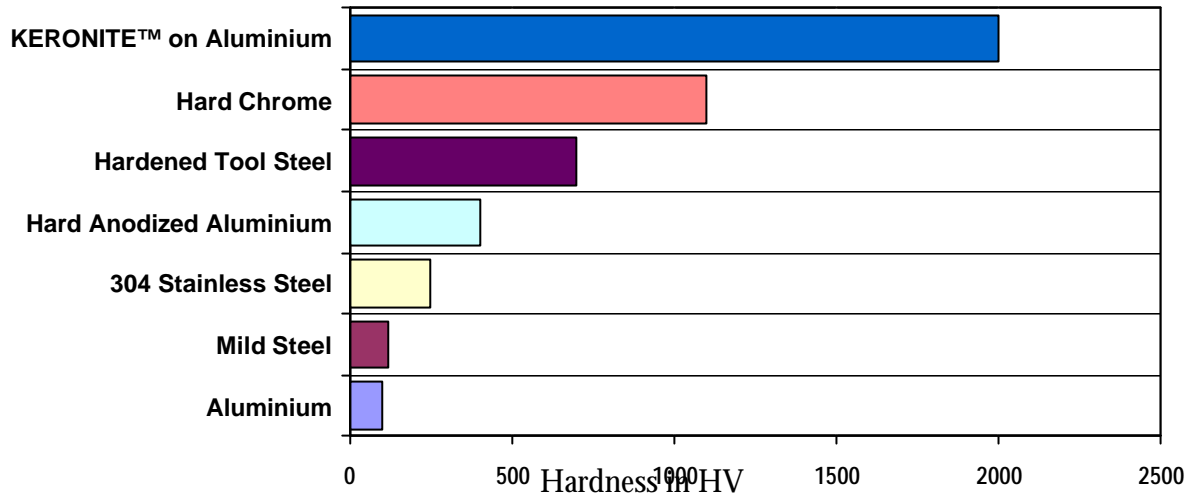
The Keronite ceramic layer is made up of two distinct sections. The fused layer closest to the substrate is very hard and extremely dense, providing excellent protection against corrosion and wear. In addition to this protective layer, Keronite has a thinner, porous outer layer which provides an ideal base for impregnation with decorative topcoats such as paints and lacquers, or can be used to form composite coatings with PTFE, adhesives, lubricants or other metals. Together the two layers have all the qualities required for the very best in functional and decorative coatings.



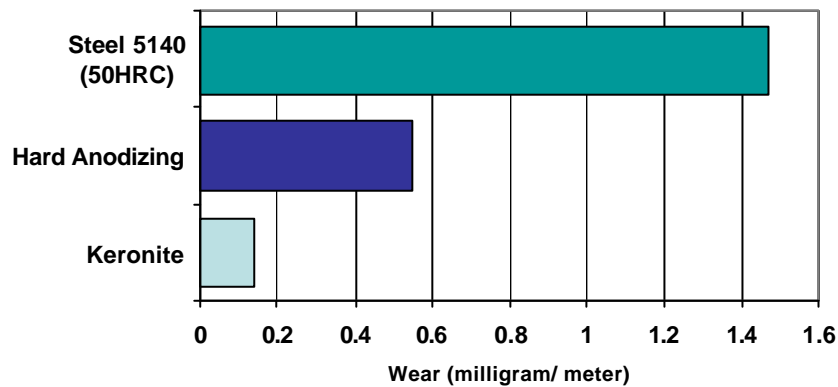
Fused Keronite Layer

Hardness and wear resistance

One of the main reasons why Keronite is used on aluminium is to increase the hardness of the surface, enabling the replacement of heavy steel or expensive ceramics in many applications.



The wear resistance of Keronite on aluminium has been evaluated by pin-on-disk method and compared with that of hard anodic coatings (Mil-C-8625 type 3) and of 5140 steel 50 HRC.



The results of this test indicated that Keronite on aluminium is at least three times more wear resistant than hard anodised aluminium, and around ten times more wear resistant than steel. The applications of this are manifold throughout the world of engineering.

In the automotive industry, Keronite on aluminium is an ideal surface for applications such as valve trains, pulleys, pumps, pistons and liners, where hardness and wear resistance can improve engine performance considerably. Even on lightweight magnesium alloys, Keronite produces a surface which is hard enough for use in engine pistons, liners, pumps and engine covers.

With a hardness of up to 2000 HV and an Ra value of less than 1 micron on aluminium, there is seven times less system wear on Keronite-coated top ring grooves than there is using the hard anodised equivalent. This reduction in wear inevitably means lower emissions and greater protection against blow-by. Keronite also enables piston manufacturers to reduce the land height, and this in turn leads to a reduction in unburned hydrocarbon emissions or so-called greenhouse gases.

Depending upon the wear pair in question and the required finish for a given application, the friction coefficient of Keronite surfaces can be modified either by changing the processing parameters, by polishing or by impregnating the nanometre-scale porous layer. Hard Keronite surfaces when polished, for example, are successful in reducing wear and friction in cylinder liners. At the other extreme, Keronite can be adapted to provide the friction and grip required on high performance racing clutches or cycle disc brakes.

Keronite as a pre-treatment

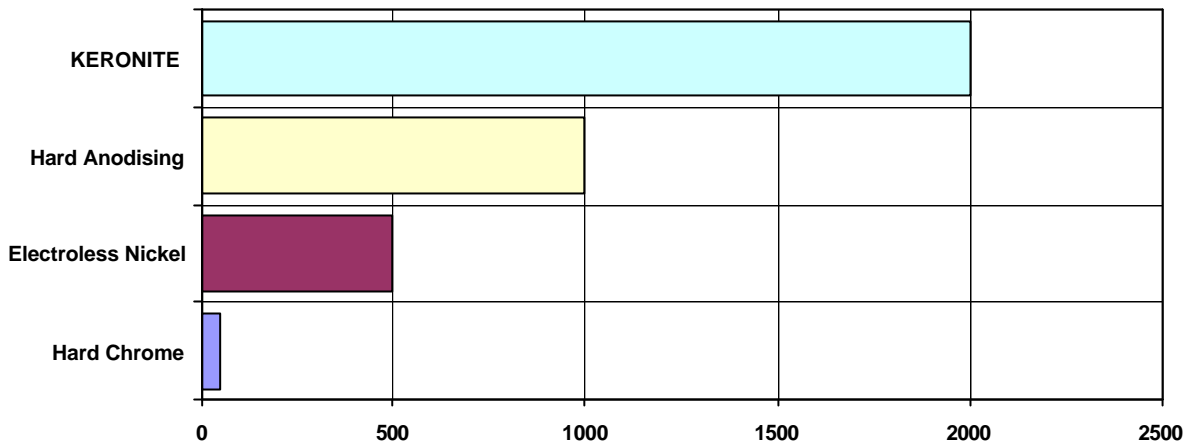
The porous outer layer of Keronite ceramic surfaces provides an ideal pre-treatment for decorative, scratch-resistant topcoats, or for impregnation with composites such as metals, adhesive or PTFE to produce unique super hard coatings. Even a very thin layer of Keronite on aluminium architectural cladding panels can improve the adhesion and scratch resistance of the powdercoat finish. In many applications requiring lubrication, the controlled porous structure of the Keronite surface also proves effective in retaining oil.

Thermal properties

The insulating properties of Keronite ceramic also provide a useful thermal barrier in many applications such as piston crowns, exhaust manifolds and cylinder heads. Tests carried out on pistons, for example, have demonstrated excellent resistance to thermal shock and thermo-cyclic loads. Keronite surfaces on aluminium can even withstand temperatures up to 2000°C for short periods without signs of cracking.

Corrosion protection

As the inner functional layer of the Keronite coating is so dense, it also provides extremely good protection against corrosion. Tests carried out in a salt fog test chamber in accordance with ASTM standard B117 have demonstrated that aluminium coated with Keronite will resist corrosion for over 2,000 hours.



Comparison with Keronite 2000 hour saltspray test

Traditionally, PEO coatings are porous and their roughness increases with the thickness of the ceramic layer. Although this can be advantageous when a good key is required for topcoats, the hardness and corrosion resistance can be limited. In recent tests carried out at Cambridge University, however, samples of AZ91D magnesium alloy were coated with only 10 microns of the latest generation of Keronite coatings, and viewed under the microscope. The surface was found to have a lenticular structure with very fine pores, and appeared very smooth and dense. This means that the coating is hard yet smooth and still has adequate porosity for good paint adhesion.

One of the limiting factors in the use of magnesium is the reputation that even the most sophisticated new alloys have for being so susceptible to corrosion. Galvanic corrosion is a particular concern as even the smallest surface scratch can quickly cause problems when brought into contact with steel or other metals. As a relatively soft metal – 30% softer than aluminium – it is notoriously prone to scratching.

However, the above-mentioned tests at Cambridge University also found that the same 10 micron layer provides a balance of good corrosion resistance and scratch resistance despite a coating time of only 2 minutes. The coated samples were scribed through to the substrate and subjected to 750 hours of salt spray in accordance with ASTM B117. The corrosion was rated according to ASTM D1654 and the Keronite samples, with a variety of topcoats, were rated 9 or 10 after 750 hours, both in scribed and unscribed areas. Those which had been finished with e-coat or powdercoat were all rated 10. The tests were continued and demonstrated that 10 microns of bare Keronite withstands a remarkable 1000hours without corrosion.

Galvanic corrosion test results are equally impressive. One sample of each coating combination was drilled before coating and fitted with a zinc-plated N6 steel bolt after coating. The bolt was fixed using a nylon nut and these tests gave an ASTM rating of 7 after 1,000 hours of salt spray.

Keronite-coated magnesium is ideally suited to applications in the consumer electronics market such as lap-top cases and mobile 'phone cases, but it is also being used to protect

magnesium racing wheels from corrosion and in a variety of automotive body and closure applications.

CONCLUSIONS

Keronite represents an environmentally friendly and user friendly non toxic alternative to traditional coating processes for light metals. Its unique properties enable users to replace steel components with light alloy components whilst retaining and enhancing surface property performance.