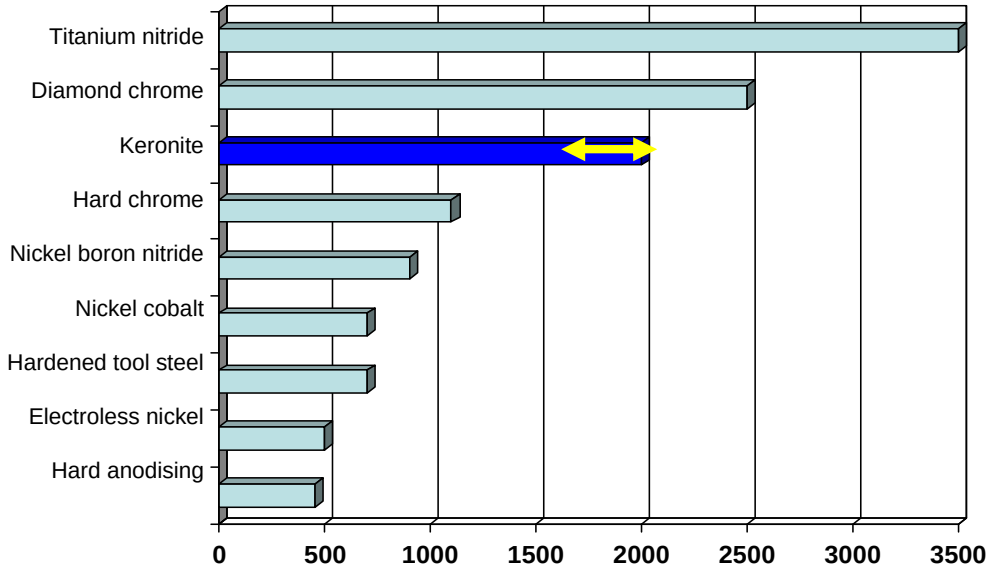
New technology cuts cost of high volume packaging

Keronite International Ltd of Cambridge, UK, is enabling manufacturers of consumer products and their plastic packaging to get a rapid return on their investment in tooling whilst at the same time increase productivity and improve the quality of their moulded parts. All this is achieved using Keronite's patented, chrome-free solution to the problem of holding tight tolerances when moulding even the very highest volumes.

The Keronite® Plasma Electrolytic Oxidation (PEO) advanced surface treatment technology extends the lifetime of aluminium moulds far beyond that of their expensive steel counterparts whilst at the same time, improving heat transfer and the associated throughput rates. It enables moulding companies to reduce tool weight and handling costs as well as the time and expense involved in tool manufacturing, helping packaging companies to get products to market in record time.

HARDNESS

Keronite surfaces are considerably harder than those of hardened tool steel and of the more widely used mould coatings. Although not as hard as titanium nitride or diamond chrome, it does have other performance advantages in terms of dimensional control and superior adhesion to the substrate.

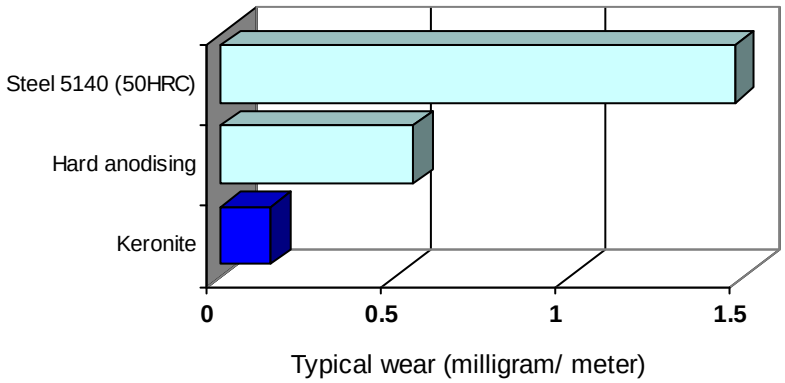


The hardness of Keronite surfaces is dependent on the aluminium alloy used and the thickness of the ceramic layer created, but it can reach as much as 2000 HV. This is well beyond the capabilities of more conventional hard anodising and even harder than steel, glass and most silicon-containing compounds. This characteristic in itself goes a long way towards creating a wear-resistant surface, but when combined with the substrate adhesion and the surprising compliance of the Keronite layer, the results are outstanding. With a modulus of only ~30 GPa, Keronite is extremely strain tolerant.

Why use aluminium moulds treated by Keronite?

- ***Rapid and relatively low-cost production cycle***
- ***Possibility of converting prototype tools for use in volume production***
- ***Mould designs can be altered quickly and cost-effectively, as required***
- ***Hard but compliant surfaces, providing outstanding wear resistance and ensuring long production life with minimal maintenance and downtime***
- ***Very thin layers of Keronite ensure dimensional accuracy within tight tolerances for minimal flash and good repeatability***
- ***Keronite duplex systems provide a low coefficient of friction and good lubricity with excellent flow and release properties***
- ***Good abrasion resistance and anti-galling properties, even along vulnerable edges of complex moulds or moving parts***
- ***Inert surface providing effective protection against corrosion or pitting as a result of condensation, gas burn or chemical attack, preventing contamination from oxidation by-products***
- ***Non-toxic process using no chrome, no acids, no heavy metals and generating no hazardous waste or non-recyclable products***

WEAR RESISTANCE

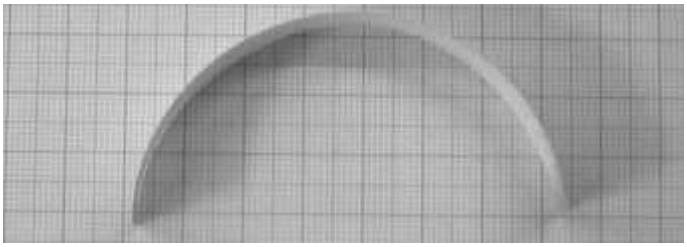


The wear resistance of Keronite was evaluated by the pin-on-disk method and compared with the wear reisistance of hard anodic coating (Mil-C-8625 type 3) and of 5140 steel 50 HRC

Up to seven times more wear resistant than hard anodising, Keronite on aluminium moulds is extremely durable and therefore able to minimise costly downtime for maintenance and repairs in high volume production.

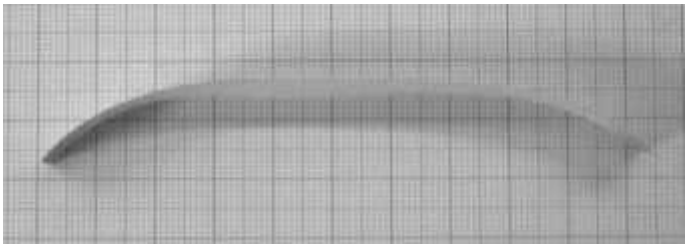
FLEXIBILITY

Research at the University of Cambridge demonstrates that the stiffness of Keronite on aluminium can be as low as 30 GPa - very unusual for such a hard surface. It is this peculiar combination of extreme hardness and surprising flexibility that makes Keronite more mechanically tolerant than other ceramic surfaces, enabling moulds to resist the strains imposed by differential thermal expansion in thermal cycling and more importantly, last that much longer.



Flexibility gives the coating resilience against small impacts or deformation of the substrate. Avoids cracking in-service

Images courtesy of University of Cambridge



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

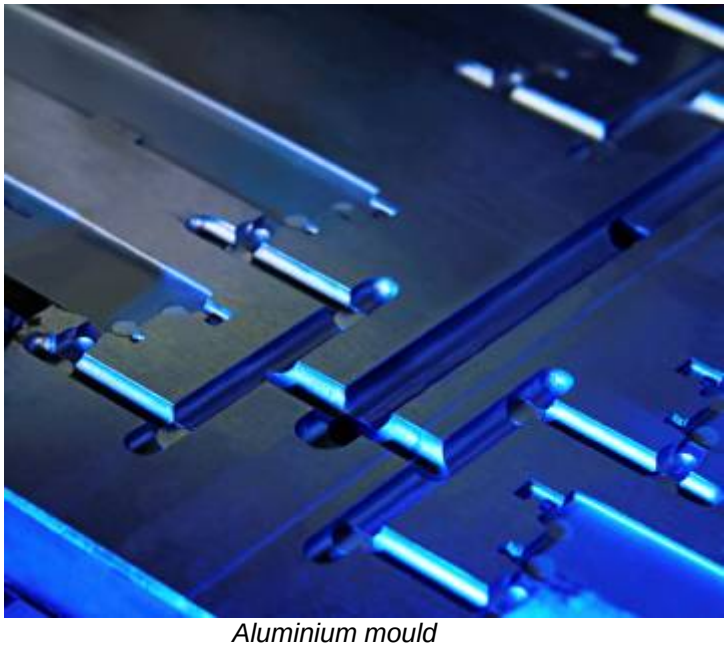
ADHESION

During the Keronite process, the exposed aluminium surface is progressively converted into a thin ceramic layer, creating a perfect interface with the base metal, free from any defects. Because of the way the ceramic layer is developed, it has much better adhesion to the substrate than any deposited coatings such as plasma sprayed ceramics, reducing the risk of potentially costly surface chipping or flaking.

DIMENSIONAL INTEGRITY

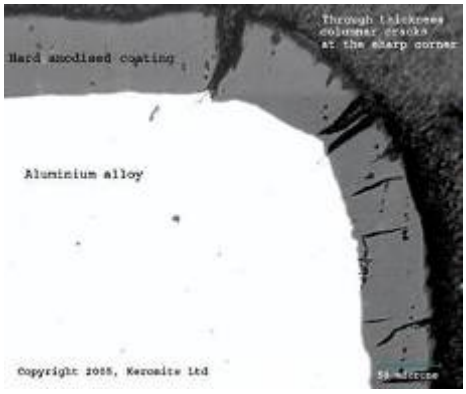
In addition to inward growth, the Keronite layer also grows outwards from the original surface, again in an extremely controlled and predictable way, ensuring good repeatability in high volume production. The extent of this outward growth depends upon the alloy selected, but it will typically reach between 10% and 40% of the total ceramic layer thickness.

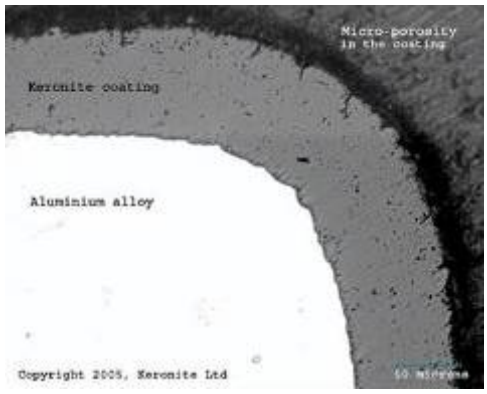
Working with Keronite, tool designers can allow for the very slight surface growth when designing a new mould, or if a smoother surface is preferred, it is possible to polish the outer layer back to the original mould dimensions using conventional methods or by wet blasting with corundum, plastic media or nut shells in a liquid medium. Either way, tolerances remain tight and dimensions repeatable making the process ideal for duplicate parts such as interchangeable cavity inserts.



Aluminium mould

Keronite is suitable for use on complex ribbed or textured moulds, protecting against wear along edges and on vulnerable corners where conventional dip-plating or painting processes fail due to surface tension or “dog-bone” effects producing thinner layers and weak spots. Hard anodising also offers limited protection in these critical areas because the nature of its columnar growth results in wedge-shaped cracks on tight radii, again creating vulnerability.





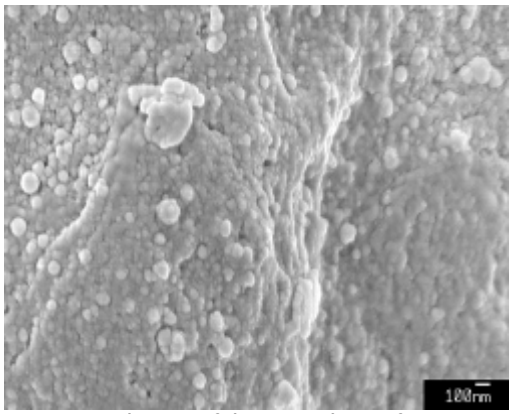
Hard Anodising *on Aluminium 7075* *Keronite* *on Aluminium 7075*

Images showing the surface protection of vulnerable corners

Keronite is different in that it shows no thinning or points of weakness on corners or edges, faithfully following the contours of the mould surface.

SURFACE ROUGHNESS

Bare Keronite has a surface roughness (Ra value) of approximately 10% of the thickness of the applied layer, together with a range of very fine-scale surface-connected porosity. This is ideal for impregnation with a variety of topcoats to produce an even more wear resistant duplex system with the required release properties and/or friction characteristics for a given mould, ensuring perfect results, time after time.



SEM image of the Keronite surface
Nanometre-scale porosity facilitates impregnation

The Keronite process transforms the surface of aluminium moulds into a layer of extremely hard ceramic. This thin but protective layer grows in a controllable fashion, providing good dimensional accuracy and enabling mould-makers to work within tight tolerances for greater repeatability and reduced risk of flash. The Keronite surface can be polished to achieve the desired level of friction and anti-galling properties for the particular plastic material in question, or the unique pore structure of unfinished Keronite can be used as the base for a duplex system, incorporating lubricants for excellent release characteristics.

ALTERATIONS AND REPAIRS

A further advantage is that Keronite surfaces can be re-processed should the tool need to be altered, machined or welded at any time.

CORROSION PROTECTION

Keronite on aluminium is particularly effective in protecting mould surfaces from pitting or corrosion caused by gas burn, acid attack or by the chlorides and sulphides generated when certain types of plastic or rubber are heated. Naturally, this protective layer will also prevent corrosion caused by condensation and it enables the use of water based resins without the usual problems associated with them. With a reduced risk of corrosion, there are unlikely to be any oxidation by-products contaminating the mould surface and causing problems in the more sensitive medical or electronics applications.

VERSATILITY

Keronite is suitable for use on a wide range of mould types, from vacuum forming, blow moulding and rotary moulding to the more aggressive forming tools and resin-bonded sand core moulding. In the case of plastic injection moulding, tool wear can be an expensive problem in high volume production, particularly in the areas directly opposite the injection points. Keronite surfaces are not only resistant to hot or abrasive plastics and additives such as glass or halogenated flame retardants, but also remain stable under temperature cycling.

AVAILABILITY

Keronite International Ltd has adopted a very flexible approach in the way it delivers this unique technology to market. The company itself offers a high quality surface treatment service from its centres of excellence in the UK, the US and China, or will happily install equipment, supply electrolyte solutions and provide engineering support to those companies wishing to treat their own components in-house or to coatings companies seeking to reach new markets.

For more information, contact Anne Wilde at info@keronite.com or see the website www.keronite.com