# *CeraFuse*™ Ceramic Restructuring

*Increases Aluminum Hardness & Improves Component Performance*

## Introduction

***CeraFuse***™ is a hard, dense ceramic surface that can be created on all types of aluminum alloys and provides for exceptional wear resistance, thermal and corrosion protection.

Since the aluminum is restructured as opposed to coated, it will not delaminate and the work piece has only minimal dimensional change. (approximately 25% of the ceramic layer thickness)

Further, a typical hard anodizing coating is 50 microns thick, ***CeraFuse***™ reaches depths of 150 microns (.006").

The hardness of the ceramic layer varies only slightly with the alloy being processed. Coatings on Al 6061 and 6063 are consistently in the range of 1100 to 1500 $Kn_{100}$.

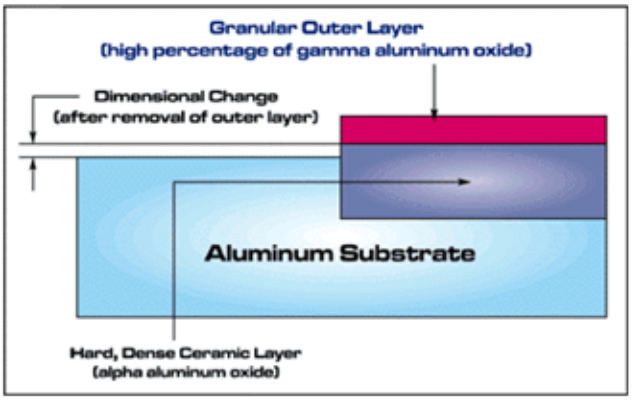
***CeraFuse***™ restructuring of lower cost aluminum provides an alternative to more expensive materials and, in many cases, components can be manufactured from aluminum rather than steel to gain the added benefit of lighter weight.

## The *CeraFuse*™ Process

Micro-arc oxidization technology (MAO) was developed in Russia nearly thirty-five years ago and is an offshoot of DC anodizing. MAO creates a plasma discharge between the aluminum substrate and the electrolyte. Even though local temperatures can reach 5,000°C or higher, the substrate temperature is maintained below 60°C.

As the process initiates, a relatively soft, granular layer forms on the surface. But as the process continues, a hard, dense inner layer of predominately alpha aluminum oxide transitions inward.

## Typical Microarc Ceramic Surface




For most applications, buffing, tumbling or other means are used to remove the outer surface before the parts are put into service. Surface finishes as low as 4 Ra can be achieved with diamond lapping or honing techniques.

## Improved Component Performance

Improved internal combustion engine efficiency has been achieved with ceramic restructured aluminum pistons:

- 3 to 8% reduction in fuel consumption
- 10 to 12% reduction in toxic emissions

Recent independent testing has verified a 7.8% average reduction in fuel usage.

Separator rolls operating on fiber extrusion machinery in the carpet manufacturing sector of the textile industry are coated with ***CeraFuse***™ to minimize wear and permit higher operating speeds.

Aluminum guide pulleys and rolls used in the manufacture of non-ferrous wire are ***CeraFuse***™ coated and last 6 to 8 times longer than anodized parts.

Air bearing sleeves and shafts are coated with ***CeraFuse***™ allowing the components to be made of aluminum, replacing steel and/or solid ceramic. Use of aluminum permits very high speeds with a lighter-weight substrate.

A family of knife sharpening products, trade named ***CeraHone***® uses ***CeraFuse***™ coating to create unbreakable ceramic sharpening tools.

## Whyco Finishing Technologies, LLC

Whyco Finishing Technologies, LLC is a leader in micro-arc oxidization technology and is equipped to process a wide variety of components in our state-of-the-art facility.

We are dedicated to customer satisfaction and in meeting ever-changing surface engineering requirements, including developing the ability to resurface magnesium and other alloys.

Whyco's design, manufacturing and quality assurance systems are based on conformance to both QS 9000 and military standards.

For more information and assistance with your application, contact us at: (860)-283-5826

Visit our Website: www.whyco.com

# *CeraFuse*™ Characteristics

## Hardness (KNOOP 100 gram load)

| | A1 2024-T4 Substrate | A1 6061-T6 Substrate | A1 7075-T651 Substrate |
|---|---|---|---|
| ***CeraFuse***™ | 1772 $Kn_{100}$ | 1660 $Kn_{100}$ | 1509 $Kn_{100}$ |
| **Hard Anodize** | 468 $Kn_{100}$ | 493 $Kn_{100}$ | 506 $Kn_{100}$ |

## Corrosion Resistance

| Sample # | Deposit Thickness | Evidence of Corrosion (hrs) | Comments |
|---|---|---|---|
| 19 | .001 - .0015" | 1268 | Surface polished before testing |
| 20 | .002 - .0025" | 1436 | Surface polished before testing |
| 21 | .004 - .0045" | 1700 | Surface polished before testing |
| 22 | .001 - .0015" | None at 1700 | Surface polished & impregnated before testing |
| 23 | .002 - .0025" | None at 1700 | Surface polished & impregnated before testing |
| 24 | .004 - .0045" | None at 1700 | Surface polished & impregnated before testing |

Testing per ASTM B-117 conducted at OMEGA Metal Laboratories and QC Metallurgical Laboratories. Material is A1 6061-T6. Initial duration of the test (per specification) was 336 hours with no evidence of corrosion. At that point, specimen was cleaned and test continued with examination every 24 hours.

## Taber Abraser Test

| Sample # | Wear Index (10k Cycles) | Wear Index (20k Cycles) | Wear Index (30k Cycles) | Wear Index (40k Cycles) | Wear Index (50k Cycles) |
|---|---|---|---|---|---|
| 1-A | 9.49 mg | 4.49 mg | 2.38 mg | 1.95 mg | 1.70 mg |
| 2-A | 8.95 mg | 4.02 mg | 2.44 mg | 1.85 mg | 1.77 mg |
| 3-L | 2.38 mg | 1.52 mg | 1.64 mg | 1.27 mg | 1.32 mg |
| 4-L | 1.79 mg | 1.14 mg | 1.45 mg | 1.26 mg | 1.23 mg |

Testing per MIL-A8625F conducted at QC Metallurgical Laboratories. Material is A1 6061-T6. Wear Index calculated as follows: WI (wear index)=(A-B) x 1000/C A=Weight of specimen before abrasion cycle B=Weight of specimen after abrasion cycle C=Number of abrasion cycles recorded. Samples 1-A and 2-A were processed in the "as-deposited" condition. Samples 3-L and 4-L were finished to Ra 16-24 prior to testing. Note: It is apparent that the "layers" of the deposit abrade at different rates during a Taber test. As might be expected, the outer or granular layer abrades rapidly and as the test apparatus contacts the denser, functional layer, the deposit exhibits a marked reduction in weight loss per 1000 cycles.

## Adhesion

| Sample # | Deposit Thickness | Fracture Area ($mm^2$) | Tensile Force (kg) | Bond Strength (MPA) | Comments |
|---|---|---|---|---|---|
| 1 | .001 - .002" | 461.86 | 505 | 10.78 | Epoxy Failed at Deposit Interface |
| 2 | .0025 - .0035" | 481.00 | 1380 | 28.12 | Epoxy Failed at Deposit Interface |
| 3 | .004 - .005" | 490.87 | 1487 | 29.70 | Epoxy Failed at Deposit Interface |

## Electrical Resistance

| Deposit Thickness | Deposit Condition | Breakdown Voltage-DC | Breakdown Voltage-AC |
|---|---|---|---|
| .001 - .0015"<br>.003 - .0035" | As Deposited | 950 – 1220<br>950 – 1600 | 460 – 490<br>640 - 910 |
| .001 - .0015"<br>.0025 - .003"<br>.0035 - .004" | Impregnated with Hi Therm BC - 346A | 3000 - 3500<br>4200 - 4500<br>5500 - 7000 | None to 3000<br>None to 3000<br>None to 3000 |

Testing per ASTM-D-3755-86 conducted at OMEGA Metal Laboratories.