Durability Comparison of
Enduramark™ Diamond Dust
316(18/8) Stainless Steel

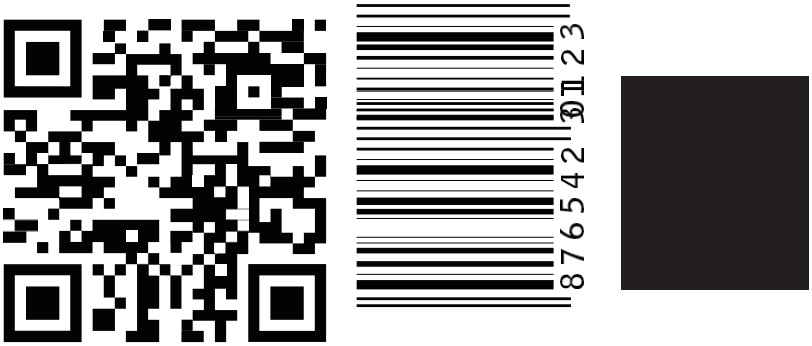
Marking of Test Samples

Enduramark™ Diamond Dust laser marking spray (LMS) was sprayed onto individual standardized 316 stainless steel tags using an airbrush system and marked according to their corresponding technical bulletins or best available known conditions using an Epilog 50-watt Helix CO_2 laser. All tests were carried out comparing the following:

Enduramark™ Diamond Dust vs. Bare Metal

Sample Test Patterns

A variety of test patterns including a UPC pattern, a QR code pattern, and a solid square pattern were tested using Enduramark™ Diamond Dust laser marking spray.



Accelerated Weathering (QUV/SE) Testing

The metal tags were placed into a QUV accelerated weather testing apparatus and subjected to repeated 4-hour cycles of calibrated UV radiation followed by 4 hours of condensation for a total of 1008 hours (42 days). The radiation cycle utilized UVA-340 radiation at 0.73W/m^2/nm simulating full intensity direct noon sunlight at 131^{o}F. The condensation cycle was performed at 122^{o}F at 100% humidity with backside cooling.

Enduramark™ Diamond Dust	Bare Metal
No Change	No Change

Results

After 1000 hours of simulated weathering no change was observed with Enduramark.

Scratch Resistance

A Hoffman Scratch Testing Device at loads varying from 0 grams to 400 grams was utilized to test and compare the scratch resistance of various markings achieved by Enduramark™ Diamond Dust, as well as bare unmarked metal.

Load (g)	Enduramark™ Diamond Dust	Bare Metal
0	No Scratch	Slight Scratch
100	Slight Scratch	Slight Scratch
200	Moderate Scratch	Moderate Scratch
300	Severe Scratch	Severe Scratch
400	Severe Scratch	Severe Scratch

Results

Enduramark provided scratch resistance at light loading compared to bare metal.

Organic Solvent Testing

The metal tags were fully submersed untouched for 7 days (168 hours) in various organic solvent and evaluated for change or damage to the markings.

Solvent	Enduramark™ Diamond Dust	Bare Metal
Gasoline	No Fading	No Change
Methyl Ethyl Ketone	No Fading	No Change
Isopropanol	No Fading	No Change
Mineral Spirits	No Fading	No Change
Xylene	No Fading	No Change
Acetone	No Fading	No Change
Ethanol	No Fading	No Change
DMSO	No Fading	No Change
Motor Oil	No Fading	No Change
Kerosene	No Fading	No Change

Results

Common organic solvents had no effect on Enduramark.

Caustic Chemical Testing

The metal tags were fully submersed untouched for varying periods of time in various caustic aqueous acids/bases and evaluated for change or damage to the markings.

Acid/Base	Duration	Enduramark™ Diamond Dust	Bare Metal
Conc. Hydrochloric Acid	30 min	No Fade	Severe Oxidation
30% Hydrogen Peroxide	3 hours	No Fade	No Change
20% Ammonium Hydroxide	8 Days	No Fade	No Change
25% Sodium Hydroxide	8 Days	Slight Fade	No Change
DI Water	8 days	No Fade	No Change
80% Acetic Acid	8 days	No Fade	No Change
85% Phosphoric Acid	8 days	Slight Fade	No Change
Conc. Nitric Acid	8 days	Slight Fade	No Change
Conc. Sulfuric Acid	8 days	No Fade	No Change

Results

Enduramark showed excellent chemical resistance to concentrated hydrochloric acid, 30% hydrogen peroxide, 20% ammonium hydroxide, DI water, 80% acetic acid and concentrated sulfuric acid. Slightly less resistance was observed with 25% sodium hydroxide, 85% phosphoric acid and concentrated nitric acid.