TECH TIP

CERMARK TESTING INFO

The pdf documents provided below are test or studies done with a CerMark Metal Marking application. Click on the links to access the information. These pdf files may require that Adobe Acrobat Reader be loaded to your system before opening.

CerMark - Durability

CerMark - NASA

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Durability Test for CerMark LMM-6000

Hoffman Scratch Testing of LMM-6000 Marks

The test was used to test both the CerMark Spray and 1 & ½ lb. Solution products. LMM-6000 was applied and marked according to the "LMM-6000 Metal Marking Material" technical bulletin. The marked areas were then scratched using a Hoffman Scratch Testing Device.

Stainless Steel

Load	Effect on Bare Metal	Effect on Marked Area
0g	Lightly Scratched	No Effect
100g	Scratched	No Effect
200g	Scratched	Partially scratched
300g	Scratched	Mostly scratched
400g	Scratched	Mostly scratched

Brass

Load	Effect on Bare Metal	Effect on Marked Area
0g	Scratched	No Effect
50g	Scratched	Partially scratched
100g	Scratched	Partially through
150g	Scratched	Scratched through
200g	Scratched	Scratched through

Aluminum

Load	Effect on Bare Metal	Effect on Marked Area
0g	Scratched	Slightly scratched
25g	Scratched	Partially scratched
50g	Scratched	Scratched through
75g	Scratched	Scratched through
100g	Scratched	Scratched through

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LMM-6000 Heat Test on Stainless Steel

Temperature	Result
800 F	Tag Darkened, Mark Reads
900 F	Tag Darkened, Mark Reads

Temperature	Result	Temperature	Result
1000 F	Tag Darkened, Mark Reads	1200 F	Tag "Blued", Mark Does Not Read
1100 F	Tag Darkened, Mark Reads After Scrubbing	1250 F	Tag "Blued", Mark Does Not Read

Organic Solvent Testing on Metal Tags

- Stainless steel, brass, and aluminum tags were marked with LMM-6000 using a YAG or CO_2 Laser
- Marks were submersed in various solvents for one week, then evaluated
- No damage was done to the marks (one failure with isopropanol)
- Solvents used: Gasoline, Limonene, Methyl Ethyl Ketone, Isopropanol, Mineral Spirits, Xylene, Acetone, Propylene Carbonate, Ethanol, DMSO, Motor Oil, and Kerosene

Chemical Testing Stainless Steel

Test Solvent	LMM-6000 Nd: YAG Laser	LMM-6000 CO_2 Laser
85% H_3PO_4 (8 days)	No Damage	No Damage
30% H_2O_2 (3 hours)	No Damage	No Damage
Conc. NH4OH	Tarnish is seen	Faster marks can be rubbed off
25% NaOH	No Damage	Faster marks can be rubbed off

Test Solvent	LMM-6000 Nd: YAG Laser	LMM-6000 CO_2 Laser
DI Water (8 d)	No Damage	No Damage
80% Acetic Acid (8 days)	No Damage	No Damage
Conc. HCl (30 min.)	No Damage to mark, metal removed around it	No Damage to mark, metal removed around it
Conc. HNO_3 (8 d)	No Damage	Mark mostly removed
Con. H_2SO_4 (8 d)	No Damage	No Damage

Chemical Testing on Brass

Test Solvent	LMM-6000 Nd: YAG Laser	LMM-6000 CO_2 Laser
85% H_3PO_4 (10 minutes)	No Damage, Tarnish Removed	No Damage, Tarnish Removed
30% H_2O_2 (3 hours)	Mark Removed	Mark Removed
Conc. NH4OH	Tarnish of brass from Cu in solution, mark visible	Mark Removed
25% NaOH	Partial Removal of Mark	Mark Removed

Test Solvent	LMM-6000 Nd: YAG Laser	LMM-6000 CO_2 Laser
DI Water (8 d)	Brass Darkened, No Damage to Mark	No Damage
80% Acetic Acid (2 hours)	No Damage to Mark, tarnish removed but reappears later	No Damage
Conc. HCl (2 min.)	30% of marked area removed	90% of marked area removed
Conc. HNO_3 (30 sec)	30% of marked area removed, tarnish removed	Mark Removed
Con. H_2SO_4 (2 min.)	No Damage, Tarnish removed from brass	Partial Removal of Mark

Chemical Testing on Aluminum

Test Solvent	LMM-6000 Nd: YAG Laser	LMM-6000 CO_2 Laser
85% H_3PO_4 (10 minutes)	Some fading of mark	Some fading of mark
30% H_2O_2 (3 hours)	Mark Removed	Mark Removed
Conc. NH4OH	Aluminum turns green, marks are visible	Aluminum turns green, marks are visible
25% NaOH (1 minute)	90% of mark is removed	Mark is faded

Test Solvent	LMM-6000 Nd: YAG Laser	LMM-6000 CO_2 Laser
DI Water (8 d)	Mark partially removed	Mark partially removed
80% Acetic Acid (2 hours)	Mark removed	Mark partially removed
Conc. HCl (1 min.)	Mark mostly removed	Mark is faded, partially removed
Conc. HNO_3	Not tested due to reactivity	Not tested due to reactivity
Con. H_2SO_4 (1 min.)	Mark partially removed	No Damage

Physical Testing of LMM-6000 Laser Marks

- Laser marks were made on type 304 stainless steel tags using LMM-6000 and a CO2 laser
- Marks were made at settings of 100% power, 12% speed, and 500 DPI on a 35 watt Universal Laser
- Tags were totally immersed in the test solutions

Chemical Testing of LMM-6000

	Exposure Time			
Organic Solvents	1 hour	12 hours	24 hours	1 Week
Gasoline	No effect	No effect	No effect	No effect
Limonene	No effect	No effect	No effect	No effect
Methyl Ethyl Ketone	No effect	No effect	No effect	No effect
N-Butanol	No effect	No effect	No effect	No effect
Mineral Spirits	No effect	No effect	No effect	No effect
Xylene	No effect	No effect	No effect	No effect
Acetone	No effect	No effect	No effect	No effect
Propylene Carbonate	No effect	No effect	No effect	No effect
Ethanol	No effect	No effect	No effect	No effect
DMSO	No effect	No effect	No effect	No effect
Motor Oil	No effect	No effect	No effect	No effect

	Exposure Time			
Acid/Bases	1 hour	12 hours	24 hours	1 Week
Hydrochloric Acid 35%	No effect	No effect	Test stopped- see notes	
Nitric Acid 68%	No effect	No effect	No effect	No effect
Sulfuric Acid (conc.)	No effect	No effect	No effect	No effect
Acetic Acid 99.5%	No effect	No effect	No effect	No effect
Hydrogen Peroxide 30%	No effect	No effect	No effect	No effect
Sodium Hydroxide 25%	No effect	No effect	No effect	No effect
Ammonium Hydroxide 20%	No effect	No effect	No effect	No effect

Other:

Boiling H20 – Marks soaked in boiling water for 1 hour: No Effect

LN2 (Cold) - Marks dipped in liquid nitrogen: No Effect

Flame (Hot) – Marks heated in a propane flame until cherry red: Metal discolors, no effect on mark

Hot/Cold Cycling – Marks heated red hot and immediately plunged in liquid Nitrogen: Metal discolors, no effect on mark

Notes:

Hydrochloric acid testing:

- Acid dissolves the steel tag and was not run over 12 hours
- After 1 hour acid dissolved 0.2767 gms of steel tag (4.7%), laser mark was unaffected
- After 12 hours acid dissolved 1.8057 gms of steel tag (30.6%), laser mark was unaffected, now having a distinctly raised feel

Sulfuric acid testing:

- Acid discolors at approximately 96 hours, mark appears slightly discolored

Autoclave Testing of LMM-6000 Marked Tags

Two sets of tags, one having been marked on the CO2 laser and the other on the YAG, were placed into an autoclave for five consecutive ½ hour cycles at 15 pounds of pressure. The tags were then removed and rated on a scale of zero to five; zero being the worst and five being the best. Once rated, the tags were then placed back into the pressure cooker for another five cycles at the same settings. Ratings were once again given to the tags. Ratings are the average of 3 tags.

First 5 Cycles

CO2 Laser

Laser Settings	Metal	Rating	Comments
100%/15%	Stainless Steel	5	Very good mark, no corrosion
100%/8%	Stainless Steel	5	Minimal corrosion, mark tainted but still in tact

YAG Laser

Laser Settings	Metal	Rating	Comments
36A/10 in	Stainless Steel	5	Very good marks, still intact, no visible damage
36A/5 in	Stainless Steel	5	Very good marks, still intact, no visible damage

Second Five Cycles

CO2 Laser

Laser Settings	Metal	Rating	Comments
100%/15%	Stainless Steel	5	Still as good as when it went in, no damage to mark or metal
100%/8%	Stainless Steel	5	Still as good as when it went in, no damage to mark or metal

YAG Laser

Laser Settings	Metal	Rating	Comments
36A/10 in	Stainless Steel	5	As good as when it went in, no damage to mark or metal
36A/5 in	Stainless Steel	5	As good as when it went in, no damage to mark or metal

LMM-6000 Salt Fog Testing

LMM-6000 marks were tested using the ATSM-B117 Salt Fog testing procedure. Marks were made on type 304 stainless steel and on aluminum. A 35 watt Universal CO2 laser and a 50 watt Lumonics YAG Laser were used for marking.

Marks were made using the following settings:

	CO2	YAG
High power, steel	100% power / 8% speed	36 amps / 5"per second
Low power, steel	100% power / 15% speed	36 amps / 10"per second
High power, aluminum	100% power / 2.4% speed	38 amps / 1"per second
Low power, aluminum	100% power / 5.0% speed	38 amps / 2"per second

The marked metal tags were weighed and then placed in a QFOG salt fog chamber. The tags were removed periodically, wiped off, and reweighed to monitor corrosive loss/gain. A visual evaluation was done at the approximate start, middle, and end of the testing. After 469 hours, the test was suspended and the results were analyzed. The weight losses of three tags of each type were averaged and plotted.

The following results were obtained:

Total weight loss

Tag	*Overall Weight Loss %*	*Tag*	*Overall Weight Loss %*
Control steel	0.0081	Control aluminum	0.1366
YAG/low power/steel	0.0069	YAG/low power/aluminum	0.204
CO2/low power/steel	0.0092	CO2/low power/aluminum	0.1962
YAG/high power/steel	0.008	YAG/high power/aluminum	0.231
CO2/high power/steel	0.0072	CO2/high power/aluminum	0.1494

QUV Testing of LMM-6000 Marks

LMM-6000 was used to mark type 304 stainless steel, brass, and aluminum tags. The tags were exposed to QUV weathering for 1000 hours.

The following results were observed:

	CO2	YAG
High power, steel	100% power / 8% speed	36 amps / 5"per second
Low power, steel	100% power / 15% speed	36 amps / 10"per second
High power, aluminum		38 amps / 1"per second
Low power, aluminum		38 amps / 2"per second
High power, brass	100% power / 2.4% speed	38 amps / 1"per second
Low power, brass	100% power / 5.0% speed	38 amps / 2"per second

Stainless Steel

Power	YAG	CO2
Hi	There is no damage to the mark or the metal the mark is on	There is no damage to the mark or the metal the mark is on
Low	There is no damage to the mark or the metal the mark is on	Black box and ID matrix both show some corrosion. Metal seems to be fine

Aluminum

Power	YAG
Hi	Most of the tag has white corrosion. Black box is spotted with some white corrosion. Mark is not very dark. I.D. matrix is very light and spotted, but still noticeable
Low	Most of the tag is covered with white corrosion. Black box and I.D. matrix are both corroded and spotty, but still well defined

Brass

Power	YAG	CO2
Hi	Black corrosion on tag. Mark turned white and is readable. I.D. matrix is well defined	Black corrosion on tag. Mark is whitish green and has some corrosion
Low	Black corrosion on tag. Mark turned whitish and is very defined, so is I.D. matrix.	Black corrosion on tag. Mark is whitish and has some corrosion but is still defined, as is the I.D. matrix

5.1.5 Laser Bonding.

5.1.5.1 Description: Laser bonding is an additive process that involves the bonding of a material to the substrate surface using the heat generated by a Nd:YAG, YVO_4, or CO_2 laser. The materials used in this process are commercially available and generally consist of a glass frit powder or ground metal, oxides mixed with inorganic pigment, and a liquid carrier (usually water). The pigment can be painted or sprayed directly onto the surface to be marked, or transferred via pad printer, screen printer, or coating roller. Adhesive backed tapes coated with an additive are also used in this process.

The process also can also be performed using a CO_2 laser and ink foils for use in less harsh environments. Laser bonding is accomplished using heat levels that have no noticeable affect on metal or glass substrates and are safe for use in safety critical applications. The markings produced using this technique (dependant upon the material used), are resistant to high heat, are unaffected by salt fog/spray and are extremely durable (see Figure 5).

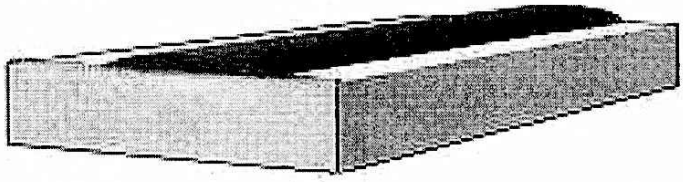

FIGURE 5. Material Fused To A Surface Using The Laser Bonding Process

Laser bonding parameters shall be established using scrap material or test coupons made of the same as the product marked.

Coating materials must be stirred or agitated vigorously to ensure that the bonding materials are in suspension.

Coatings shall be applied in a manner that ensures even distribution of the coating across the marking surface.

The settings established for laser bonding must be tested on bare metal to ensure that the heat levels applied produced no visible affect on the part surface.