

Technical Brief: DuraBlack™ Passes Durability Performance Testing

DuraBlack outperforms laser markable black anodized aluminum and acrylic labels in several simulated operating environments



Abstract

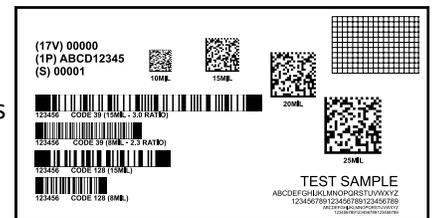
DuraBlack, a new CO₂ laser markable aluminum, meets the performance requirements of MIL-STD-130 and MIL-DTL-15024F for resistance to abrasion, high-temperature, weather, salt-spray and fluid exposure. The tests, which compare DuraBlack to black anodized aluminum, laser-markable acrylics and photosensitive anodized aluminum (Metalphoto®), simulate outdoor, marine, abrasive, fluid/chemical and high-temperature operating environments. While Metalphoto was found to be the most durable material overall; a new laser markable metal substrate – DuraBlack – exhibited environmental performance that surpassed other substrates including black anodized aluminum and laser markable acrylics.

Motivation

The usage of laser markable black anodized aluminum has increased in the past ten years with the growing adoption of CO₂ marking lasers.¹ Although black anodized aluminum can be marked effectively with a CO₂ laser, field experience and laboratory tests show that black anodized aluminum will fade outdoors – leading to label failure. In response to such reported failures, Horizons ISG developed DuraBlack™: a CO₂ laser markable material that can withstand harsh industrial and military operating environments without the post-attachment application of a protective topcoat.

DuraBlack is CO₂ laser markable aluminum that is engineered for on-demand marking in outdoor, marine, abrasive, chemical/fluid and high-temperature operating environments. DuraBlack is composed of a multi-level coating upon an aluminum base layer. Its integrated abrasion resistant coating reduces the need to apply a secondary protective topcoat. Available in both 0.005” and 0.020” thicknesses, DuraBlack can be attached to either curved or flat surfaces with adhesive, rivets or screws. DuraBlack is imaged with any CO₂ marking laser to produce a durable, high-resolution barcode or human-readable image.

The performance testing done by Horizons Incorporated was designed to compare several common label materials across a standardized battery of test conditions. Tests were modeled after those established by the U.S. Department of Defense under MIL-STD-810G (material performance) and MIL-STD-130 (identification of high value and/or mission critical assets through the UID program²). The test image on the right was imprinted on all materials evaluated. The laser markable acrylics were mounted on 0.020” aluminum.



The Test Protocols

The test protocols simulate five operating environments:

Operating Environment	Test Conditions	Success Criteria
Weather Exposure	Q-Sun XE-3/HS UV chamber as per ASTM G155	2,500 hrs
Abrasion	Taber Abraser, CS17 with 1Kg wheel load as per ASTM G195	4,000 cycles
High-Temperature	Air Oven as per ASTM D573	700°F for one hour
Marine/Saltwater Spray	Salt Spray Chamber as per ASTM B117	30 days
Chemical/Fluid Exposure	Submersion in fluids as per MIL-STD-810G	96 hrs

1 Society of Photo-Optical Instrumentation Engineers (SPIE); SPIE Professional January 2010, CO₂ Laser By DeMaria, Anthony J. and Hennessey, Jr., Thomas V. (<http://spie.org/x38563.xml>).

2 Item Unique Identification (IUID) is a part of the compliance process mandated by the United States Department of Defense. IUID requires that all DoD assets that have an acquisition cost of over \$5,000, are mission essential, are controlled inventory, are serially-controlled or are consumable have a unique identifier permanently marked that survives the life of the asset. See <http://www.acq.osd.mil/dpap/pdi/uid/index.html> for more information.

Horizons ISG does not warrant performance of its materials in any environment.

Success is defined as a passing grade (“C” or better) on the 15mil data matrix barcode using a Siemens/Microscan verifier after exposure. This measure of success was used because it is both objective (quantitative, measured by a machine) and is the established military standard for an acceptable barcode mark under MIL-STD-130N and AIM DPM-1-2006.

Materials evaluated:

	DuraBlack™ <i>laser markable aluminum</i>	Black Anodized Aluminum	Laser Markable Acrylic Tape	Metalphoto® <i>photosensitive anodized aluminum</i>
Marking Method	CO ₂ Laser	CO ₂ Laser	CO ₂ Laser	Photo Processor or Photographic Process
Base Material	Anodized Aluminum	Anodized Aluminum	Acrylic	Anodized Aluminum
Attachment Options	Adhesive or Mechanical	Adhesive or Mechanical	Adhesive	Adhesive or Mechanical

Black anodized aluminum is available from a number of suppliers worldwide. The material tested was sourced from a major U.S. manufacturer. Fiber/YAG laser markable anodized aluminum will be evaluated in subsequent tests. Laser markable acrylic (plastic) tape is also available from several sources.

Results

Among the four materials evaluated, Metalphoto® photosensitive anodized aluminum offers the best resistance to weather, abrasion, high-temperature, salt-spray and fluid exposure. Among the CO₂ laser markable products, DuraBlack™ outperformed both black anodized aluminum and laser-markable acrylic tape in select applications.

Outdoor Exposure:

DuraBlack maintained a readable, passing verification grade (see Success Criteria above) for 2,500 hours in the Q-Sun weather chamber. Black anodized aluminum faded below readability after only 1,500 hours. Laser markable acrylic tape and DuraBlack both verified after 2,500 hours in the Q-Sun weather chamber; however the acrylic label shows signs of physical deterioration (cracking/expanding). It is difficult to forecast actual outdoor life because each application environment is different, although Horizons ISG anticipates that DuraBlack will outperform laser markable acrylic tapes when attached to metal substrates.

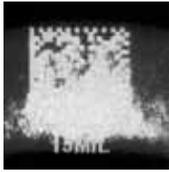
DuraBlack™	Black Anodized Aluminum	Laser Markable Acrylic Tape	Metalphoto®
			
PASS @ 2,500 hrs	FAIL @ 1,500 hrs	PASS @ 2,500 hrs	PASS @ 2,500 hrs*

* Metalphoto® was developed by Horizons ISG in 1958 and is approved for 20 yr+ outdoor usage.

Abrasive Environments:

The results of the abrasion testing were in line with expectations; top surface marked labels (DuraBlack, black anodized aluminum and laser markable acrylic tape) exhibited greater wear than labels where the image was embedded within the metal (i.e. Metalphoto®). Among the top surface marked labels, DuraBlack offered significantly greater abrasion resistance than the others.

Abrasive Environments (Cont.):

DuraBlack™	Black Anodized Aluminum	Laser Markable Acrylic Tape	Metalphoto®
			
PASS @ 4,000 cycles	FAIL @ <500 cycles	FAIL @ <500 cycles	PASS @ 8,000 cycles

High-Temperature Environments:

Materials were exposed to sequentially higher temperatures in 50°F increments, starting at 300°F, for one hour at each temperature. The 2D code marked on DuraBlack remained readable through 700°F, while black anodized aluminum failed at 400°F and laser markable acrylics failed at 550°F. The DuraBlack label, although dark still passes verification.

DuraBlack™	Black Anodized Aluminum	Laser Markable Acrylic Tape	Metalphoto®
			
PASS @ 700°F	FAIL @ 400°F	FAIL @ 550°F	PASS @ 700°F

Marine Environments:

The salt spray test is designed to simulate usage in a marine environment, as is encountered on commercial or military ships or on intermodal shipping containers. All materials verified after 30 days in the salt spray corrosion chamber.

DuraBlack™	Black Anodized Aluminum	Laser Markable Acrylic Tape	Metalphoto®
			
PASS @ 30 days	PASS @ 30 days	PASS @ 30 days	PASS @ 30 days

Industrial Fluids/Chemical Environments:

A complete list of tested fluids, including all of those under MIL-STD-810G, is noted below. Most chemicals did not have an effect after a 96 hour (4 day) submersion. However, black anodized aluminum did succumb to ammonia and alkaline cleaner after fewer than 24 hours. Similarly, laser markable acrylics did not withstand 48 hours in contact with gasoline and fewer than 24 hours with MEK and ethyl acetate. Materials were checked (verified) every 24 hours.

DuraBlack™	Black Anodized Aluminum		Laser Markable Acrylic Tape			Metalphoto®
						
PASS all @ 96 hours	FAIL @ Ammonia (<24hrs)	FAIL @ Alk Cleaner (<24hrs)	FAIL @ Gasoline (48hrs)	FAIL @ MEK (<24hrs)	FAIL @ Ethyl Acetate (<24hrs)	PASS all @ 96 hours

Fuels: Jet, Diesel, Automobile

Hydraulic Oils: Mineral Oil, Phosphate Ester (Skydrol®), Silicone

Lubricating Oils: Motor Oil, Ester (synthetic), Preservative

Cleaning Fluids: Isopropanol, Ethanol (denatured), d-Limonene, Stoddard Solvent, Aircraft Cleaner

Automotive Fluids: Deicing Fluid, Brake Fluid, Automatic Transmission Fluid, Deionized Water, 5% Salt Solution, Auto Anti-freeze

Lab Chemicals & Solvents*: Methyl Ethyl Ketone, Ethyl Acetate, Glycol Ether PM, Xylene, 10% Ammonium Hydroxide, 10% Sulfuric Acid, Greased Lightning®

*Non-MIL-STD-810G fluids tested

Summary Grid:

	DuraBlack™	Black Anodized Aluminum	Laser Markable Acrylic Tape	Metalphoto®
Weather/UV Resistance (2,500 hours)	PASS	FAIL @ 1,500 hrs	PASS	PASS
Abrasion Resistance (4,000 cycles, 1Kg)	PASS	FAIL @ <500 cycles	FAIL @ <500 cycles	PASS
Temperature Resistance (700°F for 1 hour)	PASS	FAIL @ 400°F	FAIL @ 550°F	PASS
Salt Spray (30 day exposure)	PASS	PASS	PASS	PASS
Fluid Resistance (96 hour submersion)	PASS	FAIL @ Ammonia & Alkaline Cleaner	FAIL @ Gasoline (48 hrs), MEK & Ethyl Acetate	PASS

Beyond Durability:

Beyond performance in harsh operating environments, DuraBlack has several advantages over other laser-markable materials.

1. The abrasion resistant coating reduces the need to apply a protective topcoat; a standard practice for black anodized aluminum and laser markable acrylic tape.
2. Flexible attachment options and availability in both 0.005" and 0.020" thicknesses, means that DuraBlack can be attached to either curved or flat surfaces with adhesive or rivets or screws; laser markable acrylics only allow an adhesive attachment option.
3. The aluminum base laser reduces potential damage from over marking.
4. The matte black finish reduces reflection for combat situations.

All of the above, plus consistent, high-quality manufacturing control from Horizons ISG, the trusted leader in printable aluminum technologies, makes DuraBlack a reliable solution for marking and long-term tracking of assets.

Conclusion

The tests identify DuraBlack as a preferred replacement for black anodized aluminum in most operating environments; including, outdoor, abrasive, high-temperature and fluid environments. DuraBlack performs similarly to laser markable acrylic tape in tests of outdoor weather exposure and salt-spray corrosion, and it surpasses the acrylic material in abrasion and fluid resistance. Existing and future specifications should be changed to reflect this finding.

DuraBlack is unique because of its combination of durability, flexible attachment options, thicknesses and a non-reflective finish. These characteristics make it an excellent option for on-demand marking used in harsh industrial and military environments.

DuraBlack performs extremely well, however, the tests confirm that Metalphoto® photosensitive anodized aluminum is unquestionably the most durable label material for long-term tracking of assets in harsh operating environments.

For information about DuraBlack, including how to purchase, visit www.horizonsisg.com/durablack.

About Horizons Imaging Systems Group (ISG)

Horizons Imaging Systems Group (ISG) is an internationally recognized manufacturer of printable aluminum used to produce labels, nameplates, equipment panels and more. Employing a range of processes, the company's products are produced on state-of-the-art manufacturing lines located in Cleveland, Ohio, USA. Horizons produces a variety of label substrates including Metalphoto®, AlumaJet®, AlumaMark®, ID-MARK® and DuraBlack™. For more information, visit www.HorizonsISG.com or call 800-482-7758.