



Introduction: Fluon+™ IR-MARK and UV-MARK Products

AGC Chemicals Americas, Inc.

Tuesday, Oct. 15th, IWCS Supplier Spotlight

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Your Dreams, Our Challenge



Importance of Proper Identification

- Safety issues

- Need to ensure we know which cables are high voltage / high current types, e.g. EV high voltage lines (should never be cut by first responders)
- Need to know if the cable we chose is up to the task it has been selected for, e.g. need to sure a 12-gauge wire (vs. thinner 14-gauge) for a 20-ampere 115V circuit

- Connectivity issues

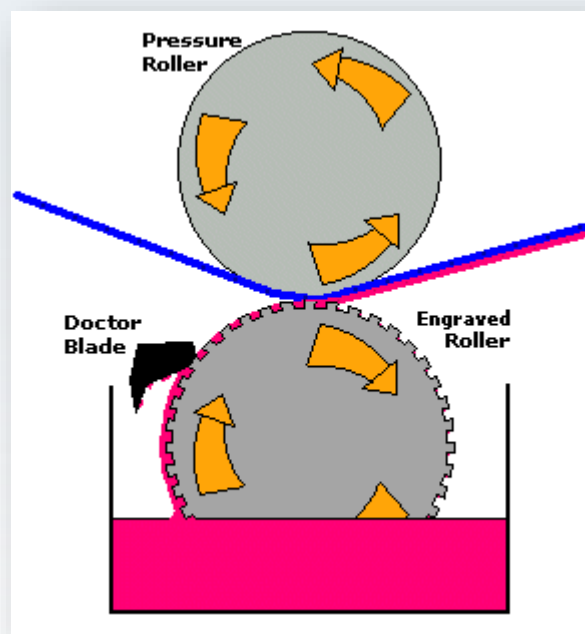
- Need to connect identical circuits across power buses, junctions, etc. (avoids cross-talk and/or short-circuits), e.g. – Deepwater Horizon blow-out preventor mis-wiring

Wire & Cable Industry ID Methods

- Colorization of the cladding itself (during extrusion)
- Co-extrusion of striping/banding with the cladding
- Post-printing (gravure, pad, ink-jet) of striping, banding, text, etc. on the surface of the cladding
 - Requires surface treatment before and after printing
 - Requires special inks
- Laser marking of the surface of the cladding

Typical Solvent-based Ink Formula

- Solvent system
- Binder system
- Pigment(s)
- Leveling agents, adhesion promoters, wetting agents, etc.

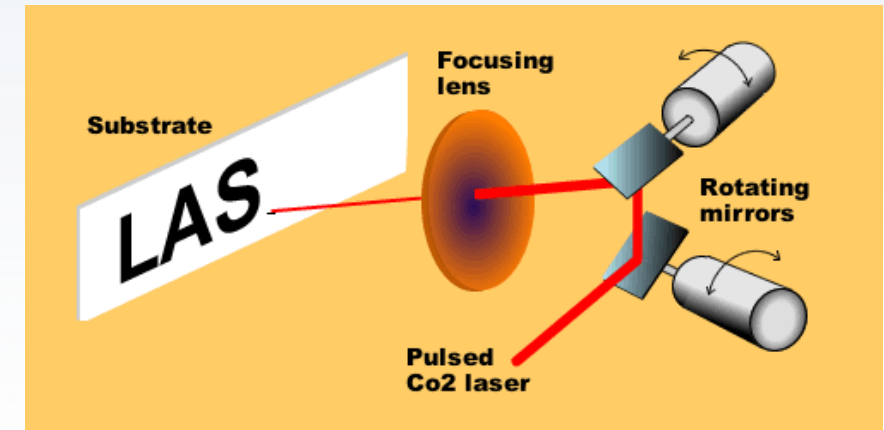


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Advantages of Laser Marking vs. Printing

- Laser marking is non-contact
- Laser marking is non-damaging when an additive system is used with the plastic cladding material
- Laser marking is faster than environmentally-friendly print methods
- Ink is not required
 - No need for hazardous print solvents
 - No need for viscosity / tint-strength adjustments by operators.
 - Surface pretreatment is not required
 - Post-treatment / post cure is not required



Disadvantages of Laser Marking vs. Printing

- Laser markings tend to be dark in color
- Laser markings work best for light-colored substrates
- Dark-colored substrates are a problem, due to poor contrast between the laser marking and the substrate
 - Additive suppliers are working on the issue
- Carbon-black claddings are a major problem

Specific Types of Laser Marking & Engraving Systems

Laser Type	Subtype	Wavelength	Mechanism	Substrates	Comments	Recommended "-MARK" Types
CO2	IR	10600nm	Char	Paper, wood, leather, rubber, plastics	Tend to be expensive; high-powered; versatile	IR; UV
Nd:YAG	IR	1064nm	Char or Foam	Metals; plastics	High power; high heat generation	IR; UV
Fiber	IR	1064nm	Char or Foam	Metals; plastics	Lower power requirements; fast (becoming the most common type)	IR; UV
Green	Visible	532nm	Char or Foam	Metals; plastics	Relatively new type; can engrave wide range of substrates	UV
UV	UV	355nm	Char or Foam	Soft plastics, glass	Can be gentle to substrates	UV

Introduction to the Fluon+ IR-MARK and UV-MARK products

- Fluon+ IR-MARK and UV-MARK products incorporate susceptor materials. These enhance reflectivity of the base material, thereby concentrating laser energy to optimize the marking process
- Laser energy is concentrated near the surface of the cladding (or part)
 - Best efficiency – parts are marked with lowest laser power settings
 - Least amount of damage (particularly important for IR)
- Products are available as concentrates for letdown in fluoropolymer resins (FEP, ETFE, PFA)
 - Other resins are possible
 - Ready-to-use formulas are possible
 - Best performance is with light colors

Core Grade Types and Applications

- Fluon+ IR-MARK products
 - Use at 1.0-5.0% loading by weight
 - Only slight impact on colorway
- Fluon+ UV-MARK products
 - Use at 2.0-10.0% loading by weight
 - Slight whitening / brightening effect on colorway

Fluon+ IR-MARK Grades (Semi-commercial)

(467015985)

(SCP) C-88AXM IR-MARK HT

- ETFE-based concentrate for use in color-critical applications with IR-laser systems
- use at 1.0% to 5.0% loading

(428015825)

(SCP) FEP IR-MARK 9800

- FEP-based concentrate for use in color-critical applications with IR-laser systems
- use at 1.0% to 5.0% loading

(442015675)

(SCP) PFA IR-MARK 3000

- PFA-based concentrate for use in color-critical applications with IR-laser systems
- use at 1.0% to 5.0% loading

Fluon+ UV-MARK Grades (Semi-commercial)

(467015986)

(SCP) C-88AXM UV-MARK HT

- ETFE-based concentrate for use with light colors and UV-laser systems
- use at 2.0% to 10.0% loading

(428015826)

(SCP) FEP UV-MARK 9800

- FEP-based concentrate for use with light colors and UV-laser systems
- use at 2.0% to 10.0% loading

(442015676)

(SCP) PFA UV-MARK 3000

- PFA-based concentrate for use with light colors and UV-laser systems
- use at 2.0% to 10.0% loading

Achieving Maximum Contrast

Colors	Laser type	Recommended - MARK(s) Types	Print will be this color	Comments
White Yellow Light Gray Light Brown Light Blue Light Green Light Violet Pink Orange Red Aqua	IR (Fiber, NdYAG, CO2) UV	IR-MARK UV-MARK	Dark brown to black Light brown to black	Important to run a “flat surface” test, using variable loading levels of the IR-MARK or UV-MARK additive system and varying power settings to determine optimums.
Black Dark Brown Dark Green Dark Blue Dark Violet	IR (Fiber, NdYAG, CO2) UV	IR-MARK UV-MARK	Dark brown to black Dark brown to black	Contrast will be reduced due to dark marking on a dark background.

Recommendations for Success – IR-MARK and UV-MARK Products

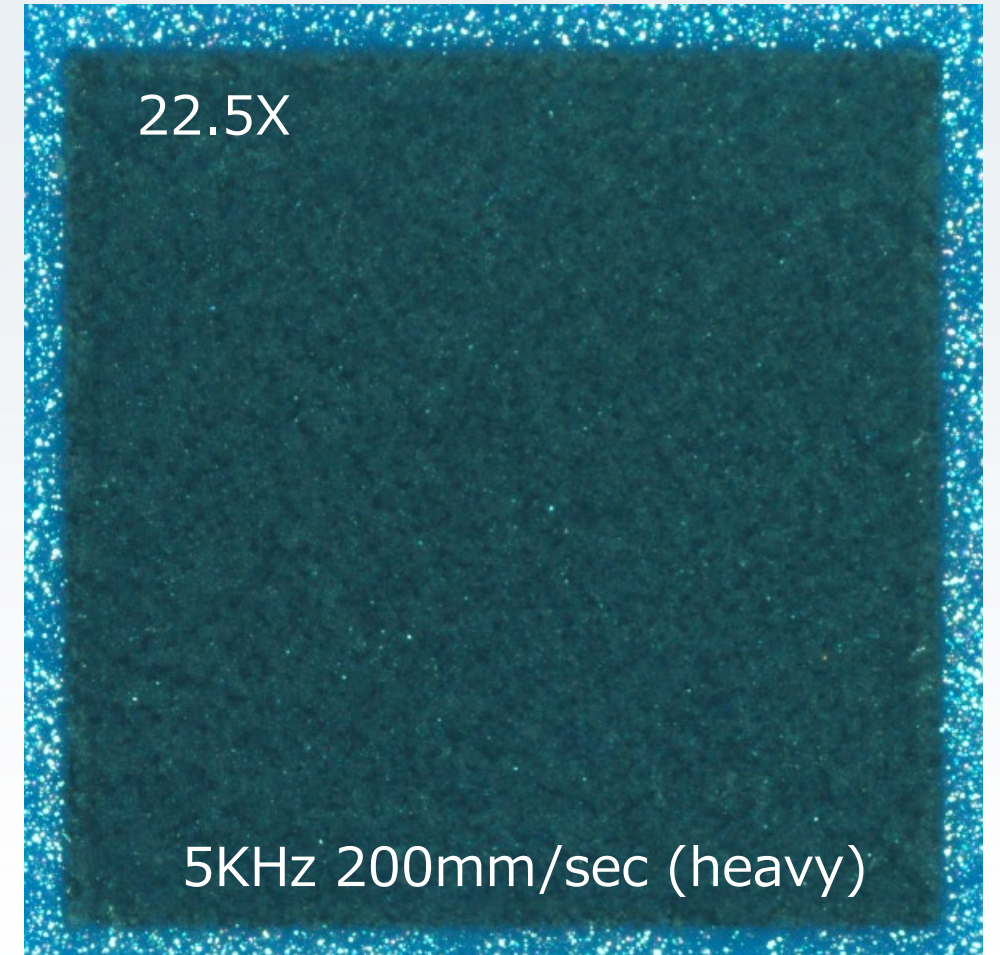
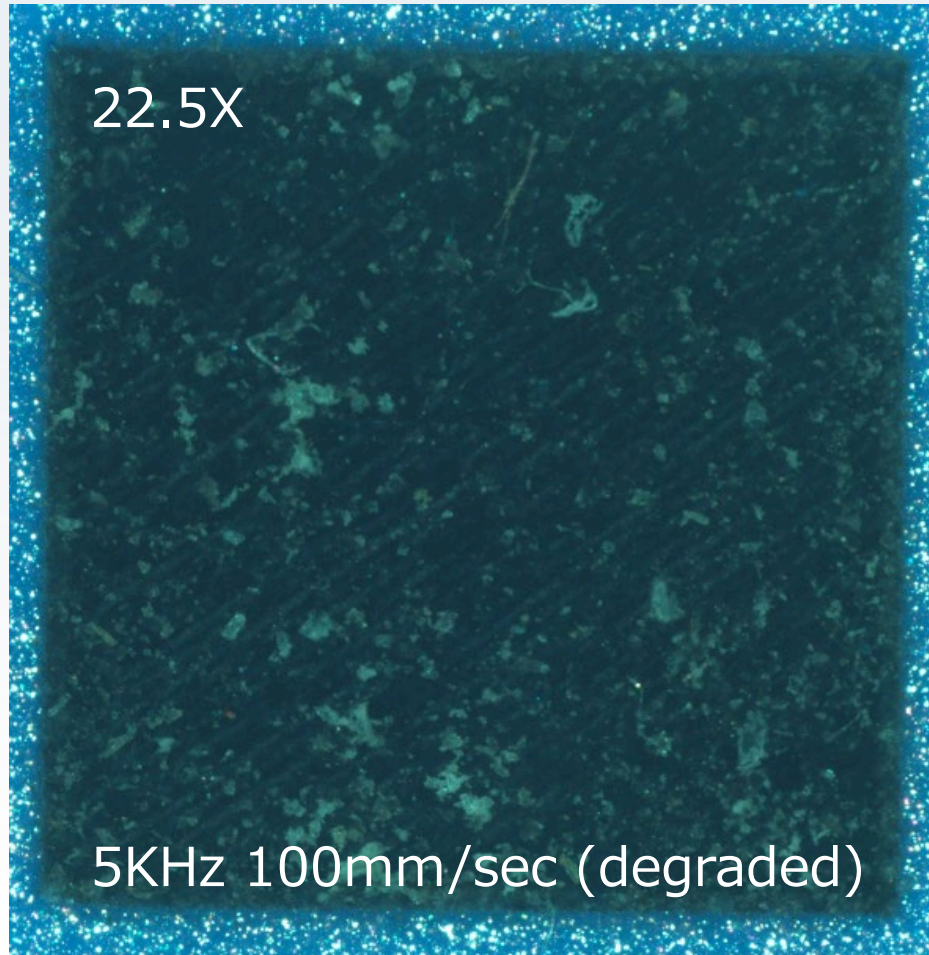
- Need to find a balance between product loading, print speed and laser power
- Printing a **test pattern** can help
 - Compounds need to be molded into a flat surface prior to testing (talk to AGC about this, as we can help!)
 - Printer manufacturers should have capability to mark test patterns on the flat surfaces
 - Photomicroscope is best used for examining print quality, resolution & location/extent of heat-affected or heat-damaged areas

IR Test Pattern Example

- Substrate = ETFE (injection-molded disk)
- Additive = C-88AXM IR-MARK HT
- Marking was performed with IR laser (fiber-type)
- Chromatic pigment (MMO blue) was used; ~0.7% loading

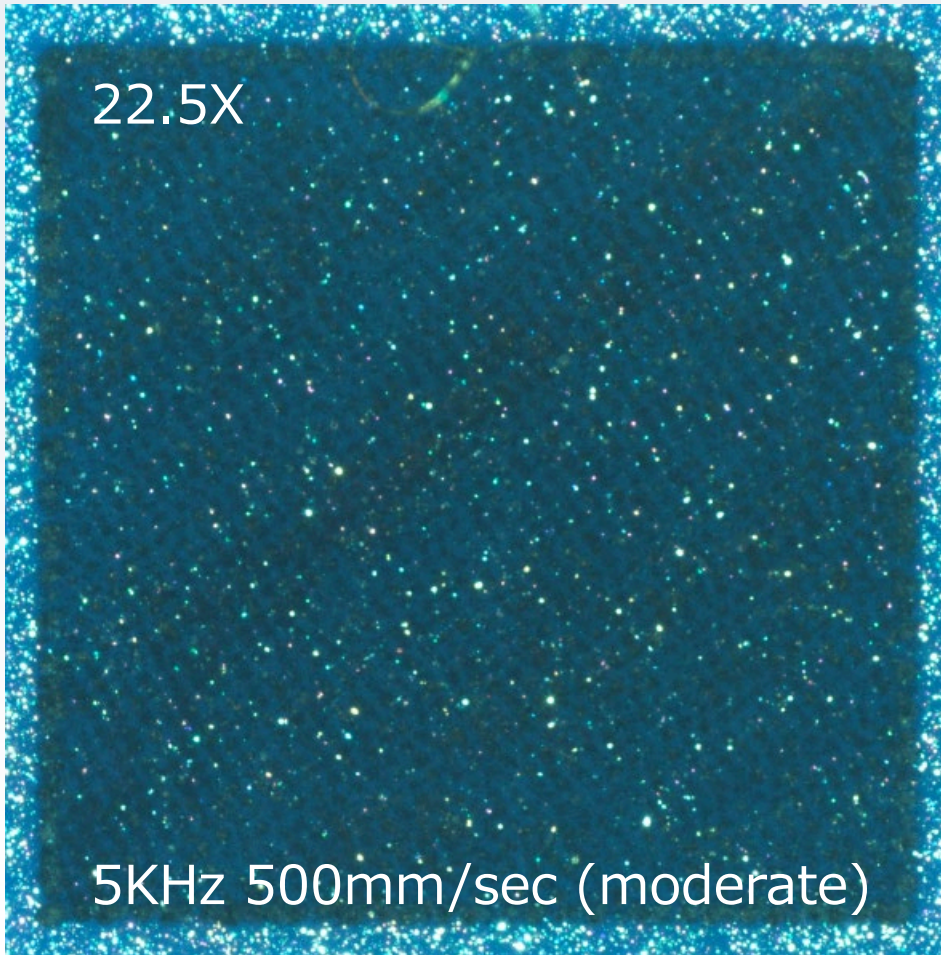
How fast can we get away with (maximum)?

How fast should we print (minimum)?

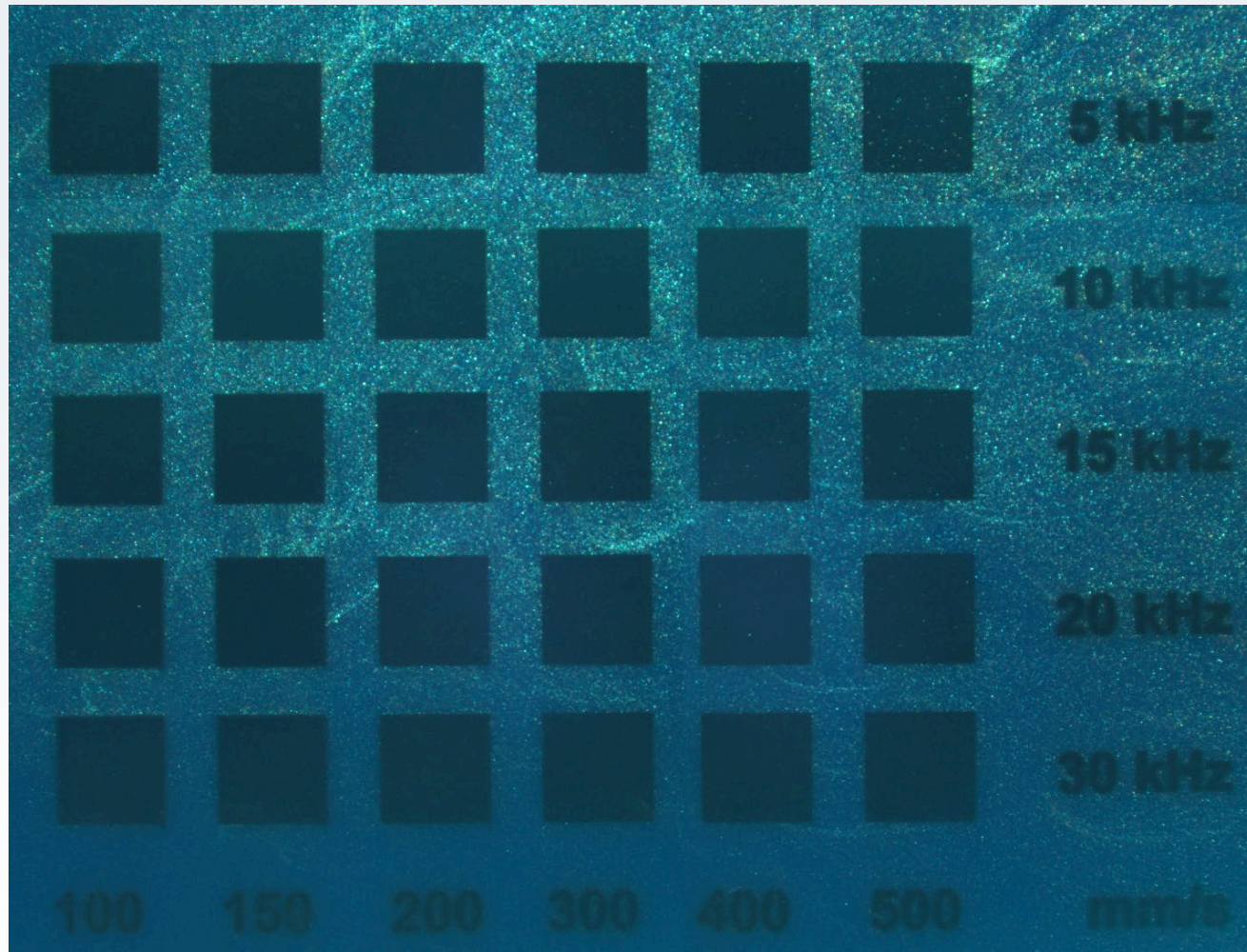


How fast can we get away with (maximum)?

How fast should we print (minimum)?

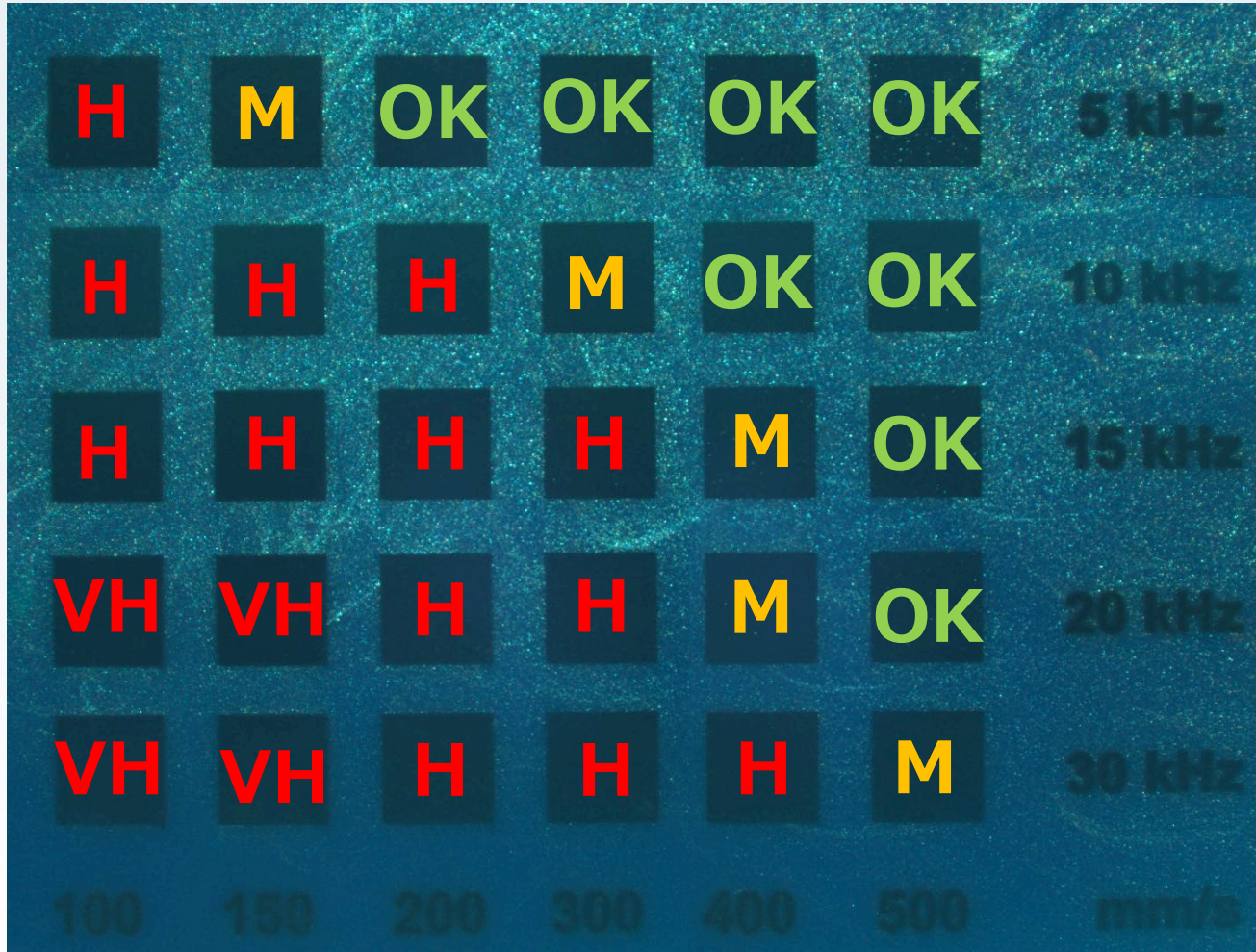


Preliminaries – (Test Patterns)



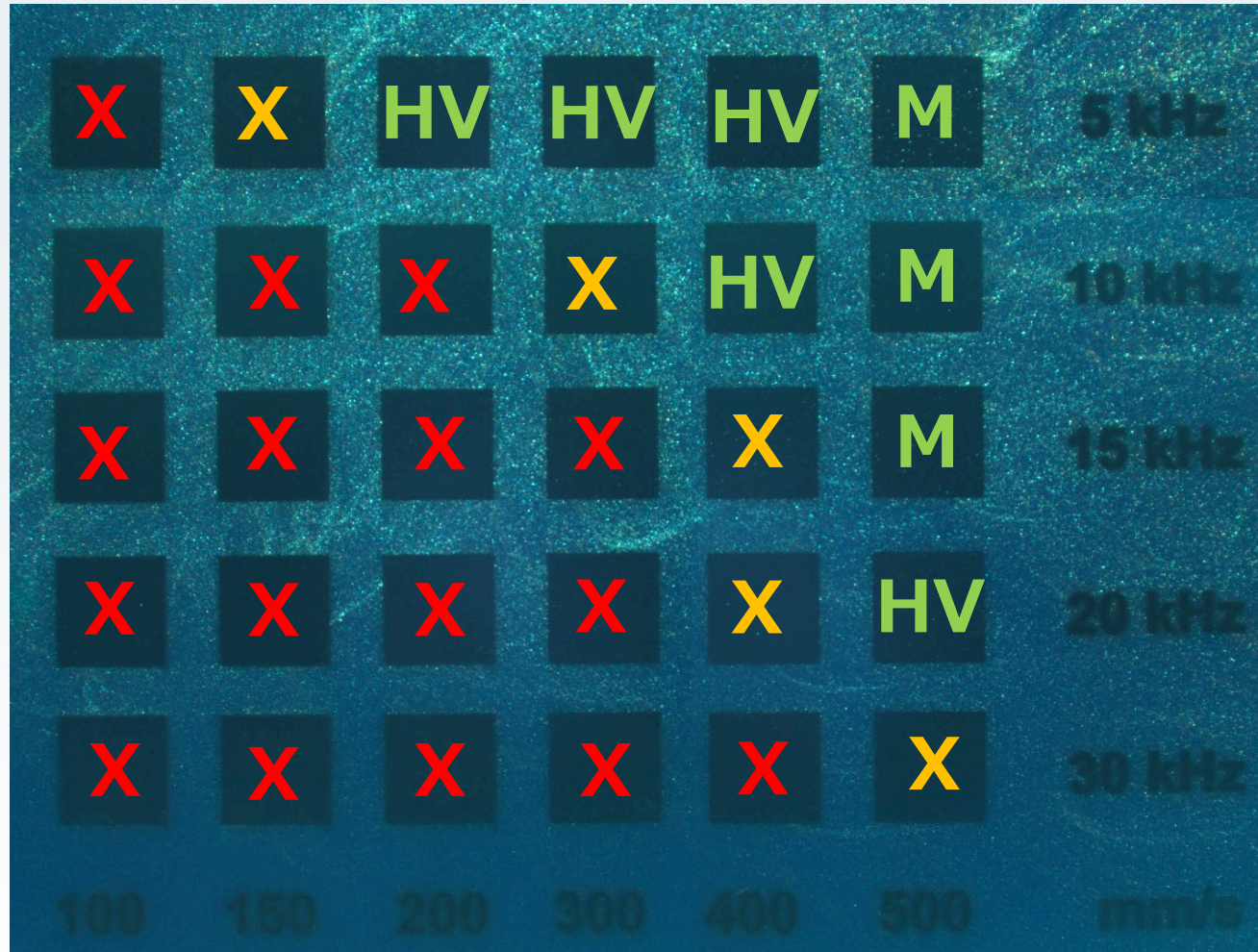
- Pattern to the left incorporates print speed and laser power settings into one useful grid
- Need to balance print speed and laser power for maximum resolution at minimum damage

What settings should be avoided?



- Very heavy degradation –
 - 30kHz (100; 150; 200mm/s)
 - 20kHz (100; 150mm/s)
- Heavy degradation
 - 30kHz (300; 400mm/s)
 - 20kHz (200; 300mm/s)
 - 15kHz (100; 150; 200; 300mm/s)
 - 10kHz (100; 150; 200mm/s)
 - 5kHz (100mm/s)
- Moderate degradation
 - 30kHz (500mm/s)
 - 20kHz (400mm/s)
 - 15kHz (400mm/s)
 - 10kHz (300mm/s)
 - 5kHz (150mm/s)

What settings work best?



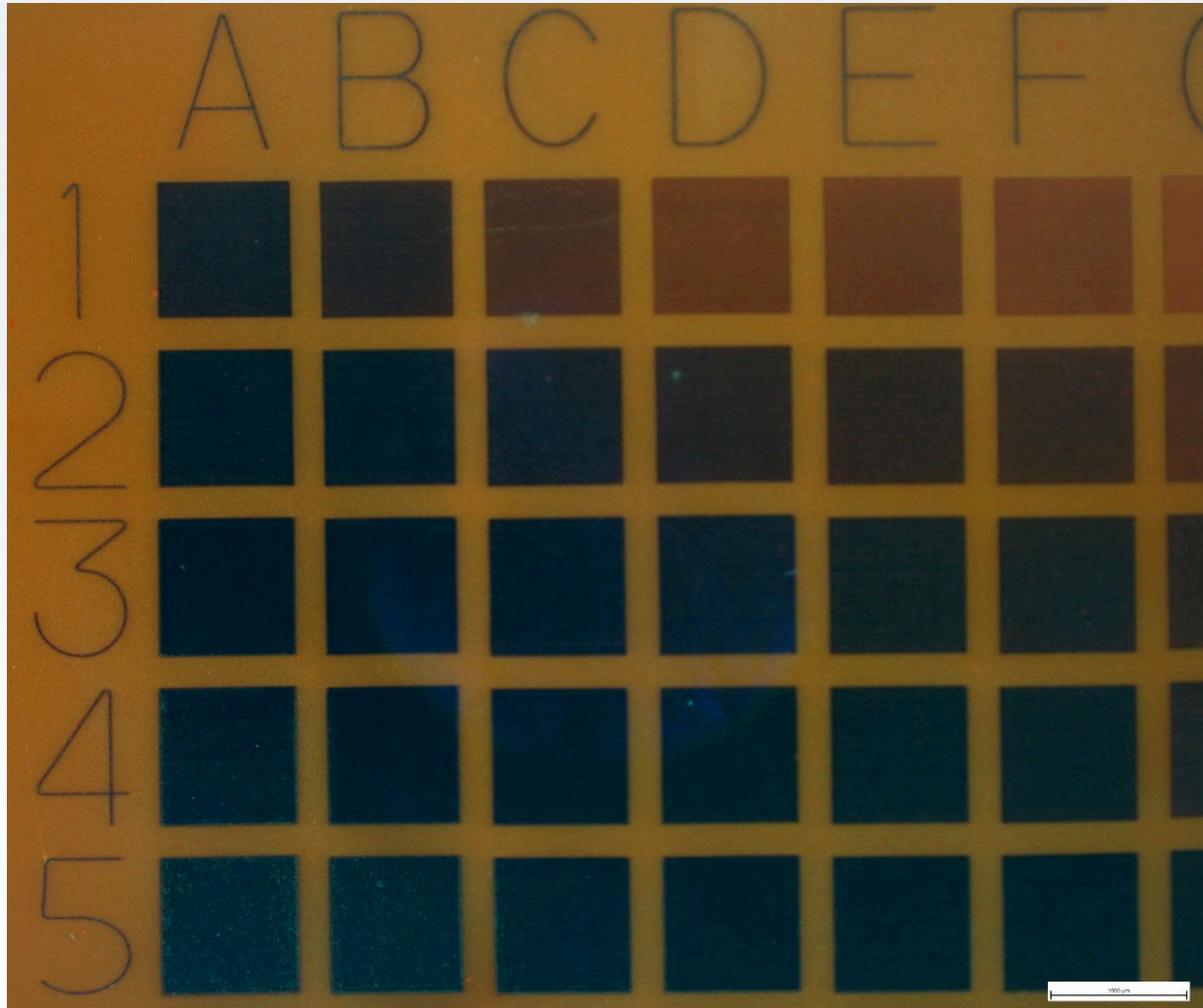
- Okay but heavy marking
 - 20kHz (100mm/s)
 - 10kHz (400mm/s)
 - 5kHz (200; 300; 400mm/s)
- Okay with moderate pixelation
 - 20kHz (500mm/s)
 - 15kHz (500mm/s)
 - 10kHz (500mm/s)
 - 5kHz (500mm/s)

Best results are attained at 500mm/s, at the 5kHz to 15kHz power settings. Fluon+ IR-MARK is working as predicted in this scenario.

UV Test Pattern Example

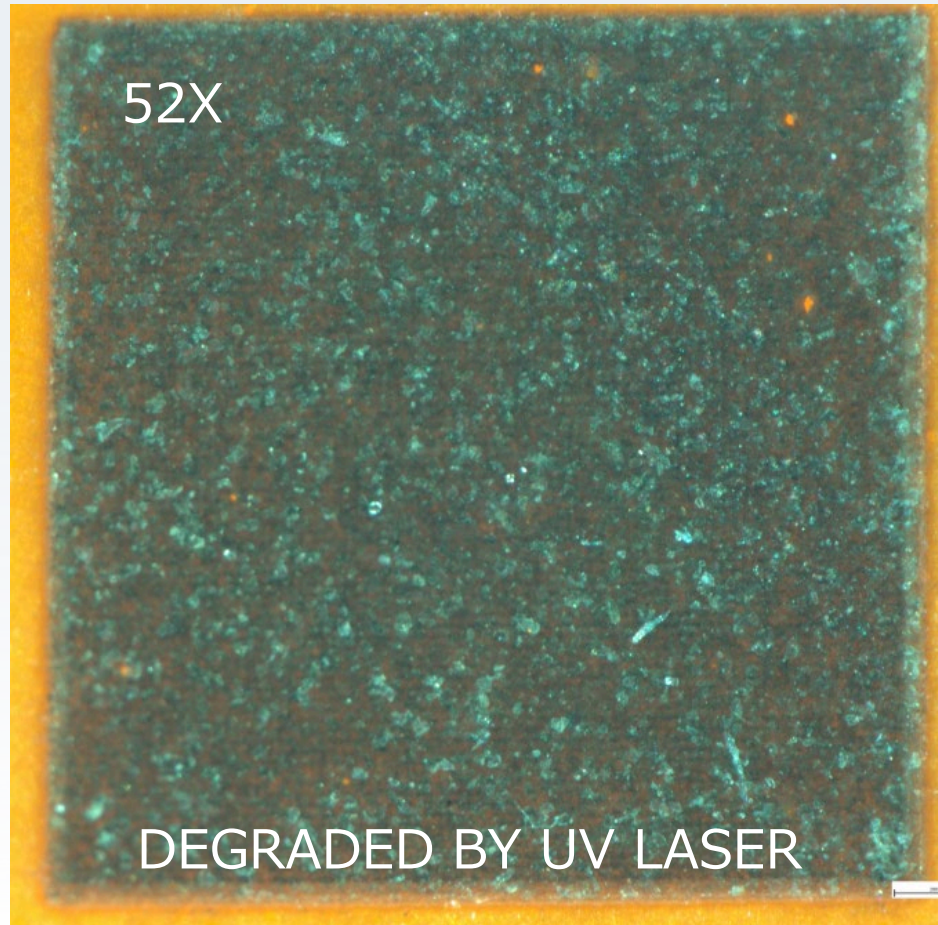
- Substrate = ETFE (150μm thickness)
- Additive = C-88AXM UV-MARK HT
- Marking was performed with UV laser (fiber-type)
- Chromatic pigment (organic orange) was used; ~0.25% loading

UV Laser Test Pattern



- Pattern to the left incorporates print speed and laser power settings; same as for IR types
- Smaller heat-affected area (smaller pixels are possible)
- As before – need to balance print speed and laser power for maximum resolution at minimum damage

It is possible to damage fluoropolymer cladding with a UV laser.



- Fluon+ IR-MARK and UV-MARK products were designed to optimize laser marking efficiency in fluoropolymers. (Lower power and faster print speed with less heat damage.)
- New standard IR grades have less impact on colorways (which will not be as dark) than previous Generation 1 products
- Standard UV-MARK grades are a new addition for 2024.
- All standard products are now available in stand-alone concentrated forms.
- Custom products (ready to use; other base resins) are available upon request.

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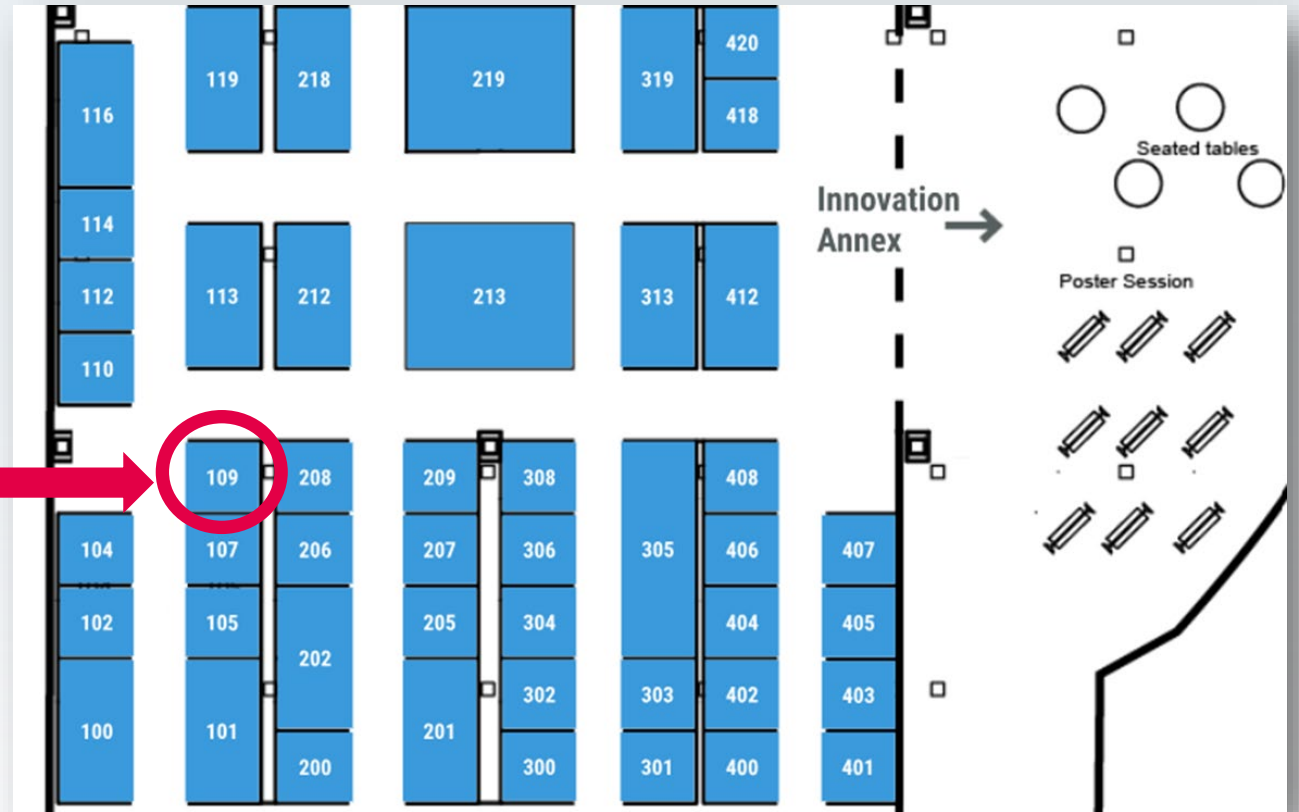
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