RMI

RMI LASER

Focused Solutions™

Laser Marking Basics

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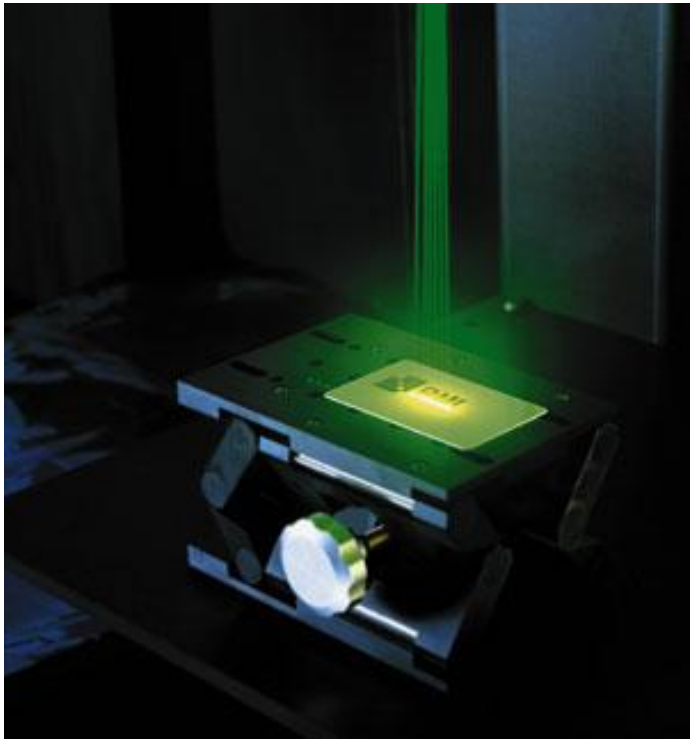
Laser Marking 101



-Defining Laser Marking

- •Collection of methods to mark parts directly using lasers

- L.A.S.E.R

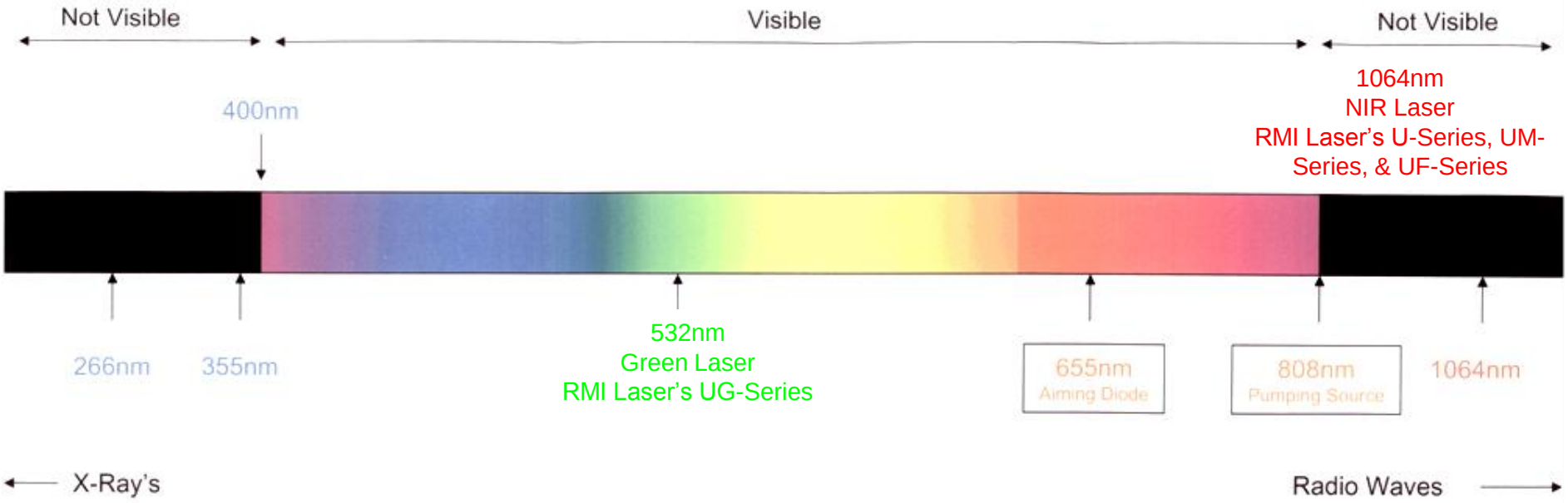
- •**L**ight **A**mplification by the **S**timulated **E**mission of **R**adiation

-T.R.A.S = 100%

- -Transmission
- -Reflection
- -Absorption
- -Scatter

Laser Marking 101 – Wavelengths

- 10.6um (Far-IR)
- 1064nm (Near-IR)
- 532nm (Green)
- 355nm (Ultraviolet (UV))



YVO_4 Harmonics

1064nm
532nm
355nm
266nm

UV — Shorter Waves, Better Absorption, Less Heat

IR — Longer Waves, Less Absorption, More Heat

Laser Marking 101 – Laser Marking Technologies | CO_2

Common Characteristics

- Gantry Driven
  - Operate in CW Mode, not pulsed
  - Rely on H/W for accuracy
  - H/W has limited duty cycle
- Flatbed Stand Alone Units
  - Marking Areas from 12”x24” and larger
- Gas Medium – Carbon Dioxide
  - CO_2 Filled Tubes
  - Consumable
- Extreme Thermal Energy
  - 10.6um Far-IR Wavelength
- Large Spot Size of 400 microns

Common Materials and Applications

CO2 Lasers are most commonly sold to hobbyists, artists, and promotional/gift shops.

- Wood
- Glass
- Stone
- Leather
- Paper/Cardboard
- Some Plastics
- Anodized Aluminum
- Will not mark directly onto metals

Laser Marking 101 – Laser Marking Technologies | Nd: YVO_4

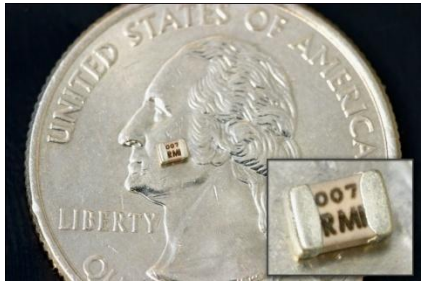
Common Characteristics

- •Galvo-Scan Heads
  - •Pulsed lasers, high peak powers
  - •Greater Accuracy/Repeatability
  - •Maximum Marking Area: 12”x12”
- •Short Pulse Duration (8ns)
  - •Creates high peak power
  - •Limits Heat Affected Zones
- •Crystal Medium
  - •Yttrium Vanadate Crystal
  - •Can double and triple frequency to get 532nm Green of 355nm UV
- •Tight spot sizes
  - •Average of 40 microns or less

Common Materials and Applications

Nd:YVO4 lasers are the most versatile laser markers as they come in 1064nm, 532nm, and 355nm wavelengths along with a variety of wattages ranging from 5-30. Typically, these units are used in an industrial production environment.

- •All Metals
- •Plastics
- •Ceramics
- •Semiconductor Materials
  - •Integrated Circuits
  - •Printed Circuit Boards
  - •Wafers
- •Will not mark glass, wood, or stone



Laser Marking 101 – Laser Marking Technologies | Nd:YAG

Common Characteristics

- Galvo-Scan Heads
  - Pulsed laser
  - Greater Accuracy/Repeatability
  - Maximum Marking Area: 12”x12”
- Short Pulse Duration (8ns)
- Operate better at lower frequencies 5-10kHz
- Crystal Medium
  - Yttrium Aluminum Garnett
    - Some use YAG rods
- Tight spot sizes
  - Average of 40 microns or less

Common Materials and Applications

Nd:YAG lasers are very similar to YVO4 except for they use a YAG crystal. Formerly Lamp-Pumped but now solid-state, this technology has mostly been replaced by YVO4 and Fiber but there are some companies still using YAG lasers today.

- All Metals
- Most Plastics
- Some Ceramics
- Will not mark wood, stone, or glass

Laser Marking 101 – Laser Marking Technologies | Yb: Fiber

Common Characteristics

- Both Galvo and Gantry Units
  - Fiber Module provides pulsing and is adaptable to each style
  - Marking area varies by style
- Long Pulse Duration (100ns)
  - Limits Pulse Peak Power
  - Increases heat, marking depth
  - Causes surface degradation or Heat Affected Zones
- Doped Fiber Arrays
  - The laser is generated in the fiber cable itself via doped fiber arrays
  - Starting to develop 532nm models
  - Prevents need for resonator or any optical alignment
- Very tight spot sizes
  - 20um and does not vary much with larger lenses

Common Materials and Applications

Fiber lasers have become increasingly popular and commonplace in spite of the limitations they have from an applications standpoint.

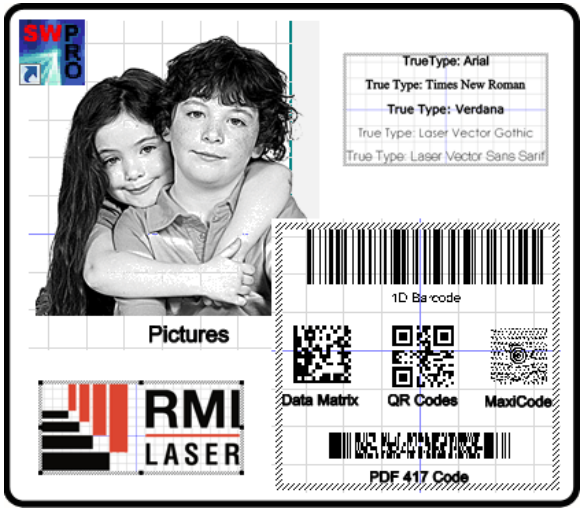
- All Metals
- Some Plastics
- Some Ceramics
- Will not mark glass, wood or stone

Laser Marking Systems Overview – System Components

Scan Head

F-Theta Lens

LD Controller



- Scan Head (Marker Head)
  - Includes Optical Resonator & Galvo-Scanning Mirrors
- F-Theta Lenses
  - 100mm (2.5” square marking area)
  - 163mm or 165mm (4.5” square marking area)
  - 254mm (6” square marking area)
  - 330mm (8” square marking area)
  - 420mm (10” square marking area)
- Laser Diode (LD) Controller
  - Includes Laser Diode, fiber optic cable assembly, system controls, safety buttons
- Software
  - Proprietary – Symbol Writer Pro
  - 3rd Party – Winlase or Prolase
  - Print Drivers – Corel Draw
  - Allows for marking of static or serialized alpha-numerics, coding, graphics, logos or photo quality images

Laser Marking Systems Overview – System Configurations

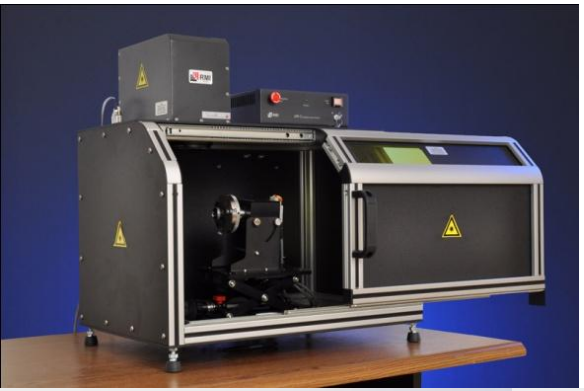
- Class I
  - Completely encloses laser light
  - Interlocked for user safety
  - Stand Alone or Desktop Workstation
- Class IV
  - Exposed laser beam, operators will need laser safety goggles
  - Nomical Occular Hazard Distance (NOHD) is ~ 10 feet
  - Stand Alone, Desktop Workstation, or inline (depending on application)
- OEM
  - Just the marker head and diode controller
  - For use with inline production, automated or integrated models, or for private label

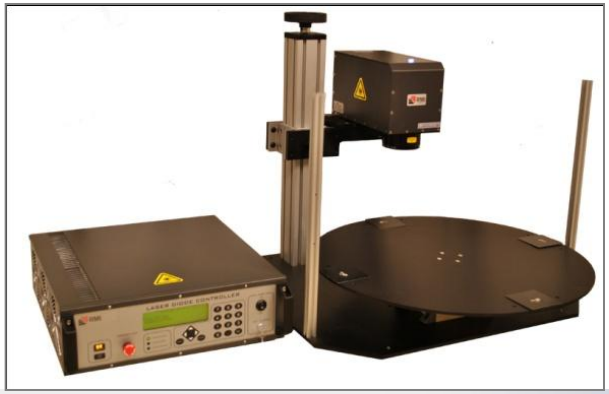
OEM

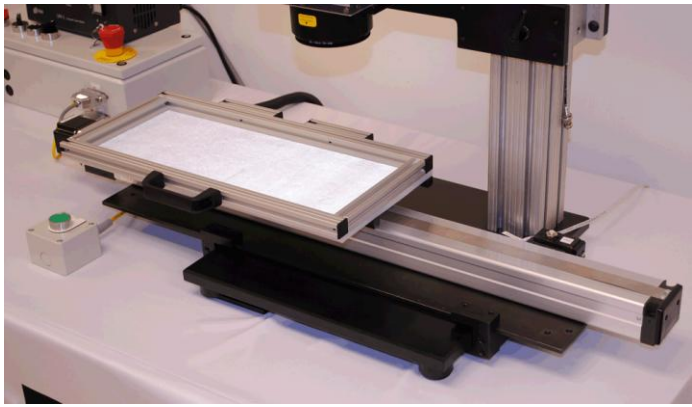
Class 1

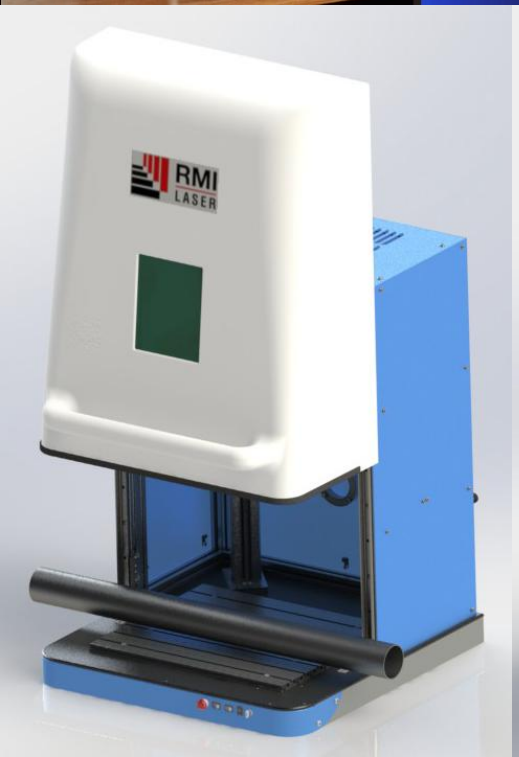
Class 4

Laser Marking Systems Overview – Other Hardware/Accessories

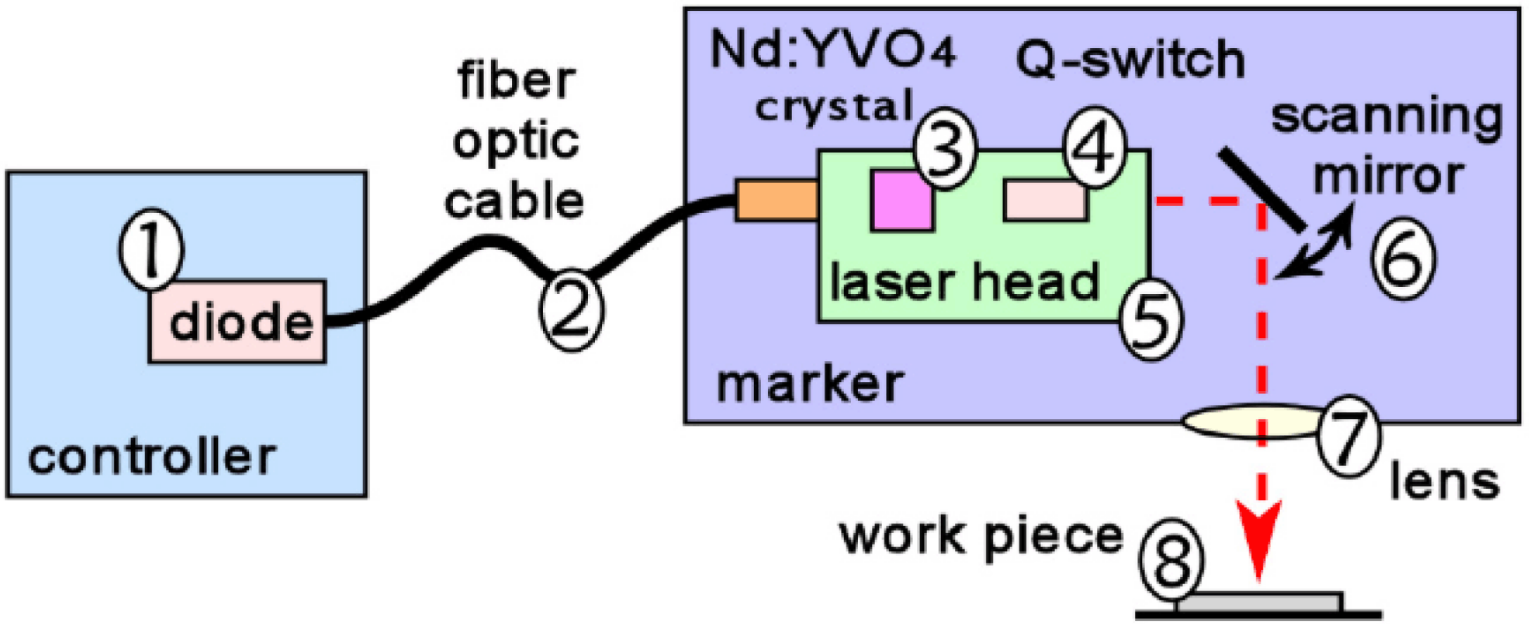








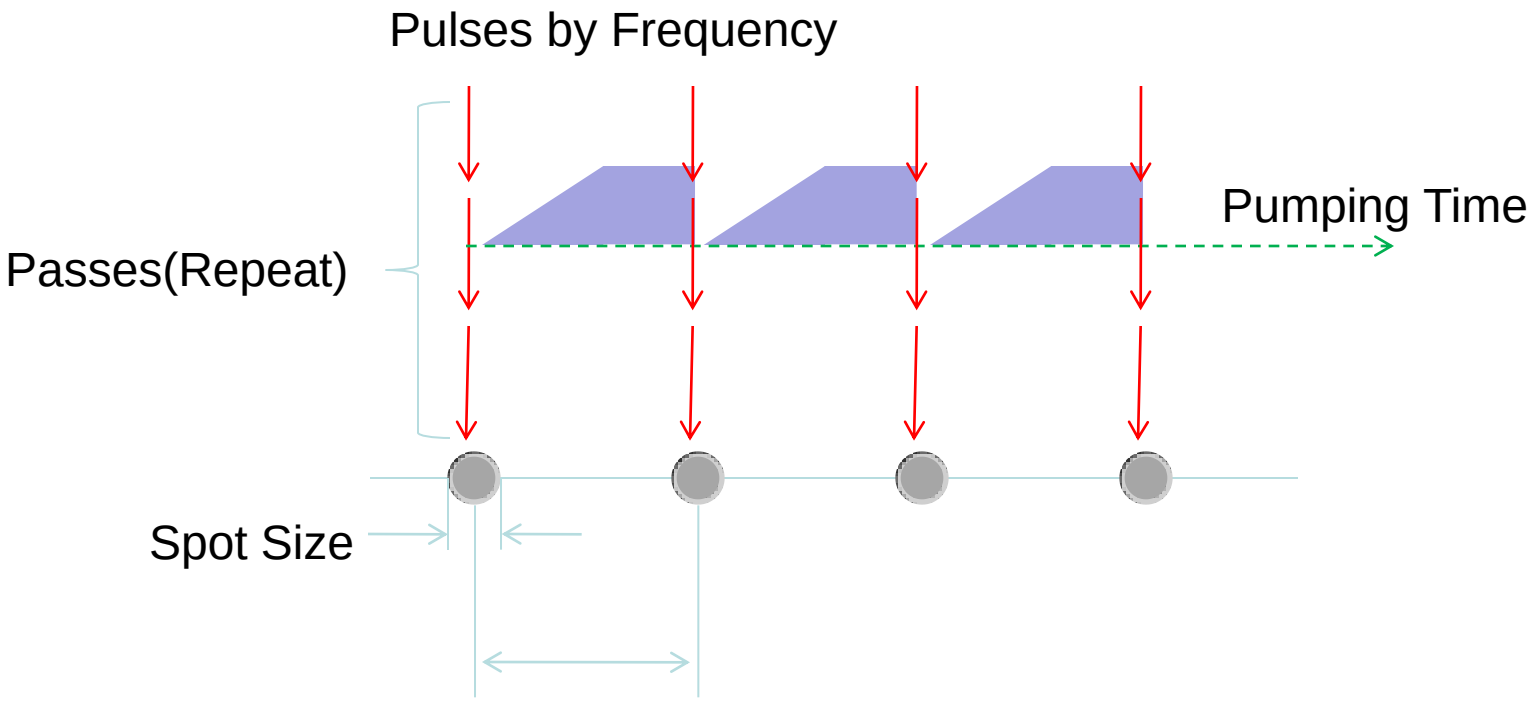
Laser Marking Systems Overview



1. Laser Diode pumps 808nm light
2. Fiber Optic cable allows light to travel to laser scan head
3. Nd:YVO_4 Crystal absorbs the 808nm and refracts light producing a CW 1064nm laser
4. Q-Switch converts the CW 1064nm light into a stream of intense laser pulses
5. The Resonator (laser head) contains many optical components, most importantly the Nd:YVO_4 crystal and the Q-switch
6. Galvanometer Scanning Mirrors on X and Y Axis steer the beam onto the work piece
7. F-Theta Lens focuses the beam onto the work piece. Working distances and areas vary with each lens size
8. Work piece is the metal, plastic, ceramic, composite material that is to be mark by the laser at the proper focal height

Parameters for Marking

II. Marking Quality



Step Size
by Frequency and speed(Vector, Fast Raster)
by Step size (Raster, Contour)

Parameters for Marking

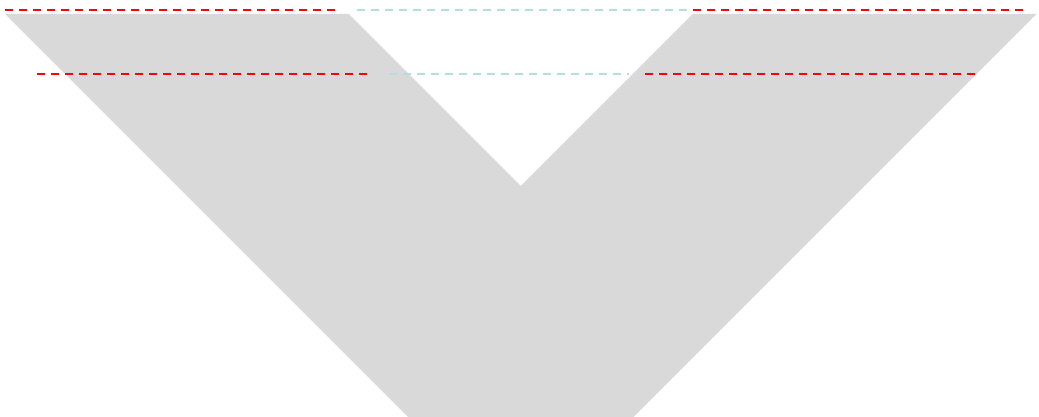
II. Marking Quality

- Marking Type
  - Contour
  - Raster

Freq. by Speed
Step by step size

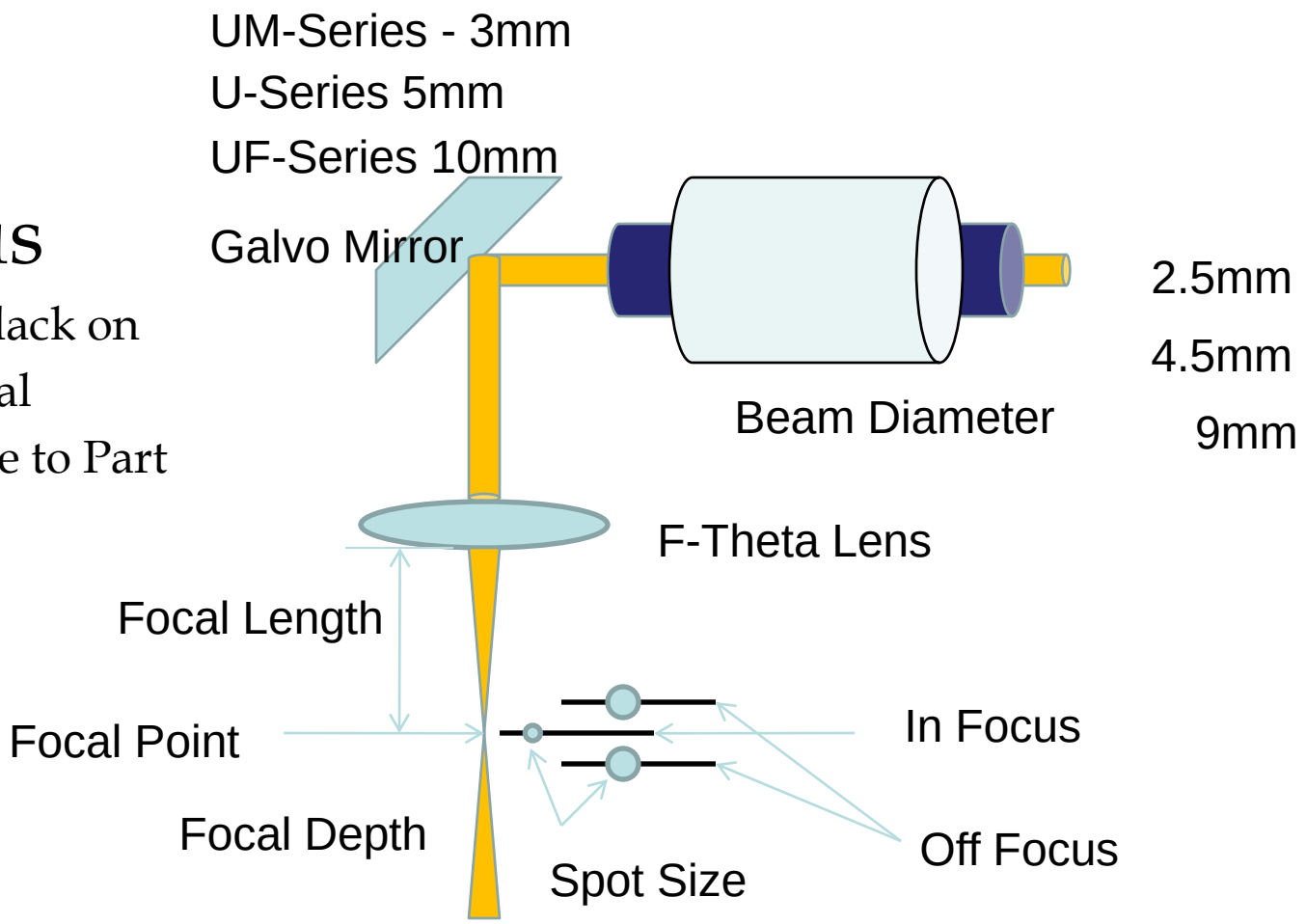
  - Vector
  - Fast Raster

Step by Freq. and speed



Focal Point II. Marking Quallity

- In Focus
  - Engraving
- Off Focus
  - White or Black on Shiny Metal
  - No Damage to Part



Laser Marking Applications

DOD/Military tool tracking (Gov)

Code Marking (Traceability)

Sterile marking (Medical)

Zero impact marking (Aerospace)

Product identification (Manufacturing)

ID cards (Security)

Product personalization (Jewelry/Gift)

How our systems helps with Quality Control

- Indelible Marks
- Traceability
- Data Matrix
- Minimal HAZ (Heat Affected Zone)
- Auto Serialization/Date & Time Coding
- Depth Control
- Database connectivity
- Can be integrated with vision systems and automated production lines for a variety of control features

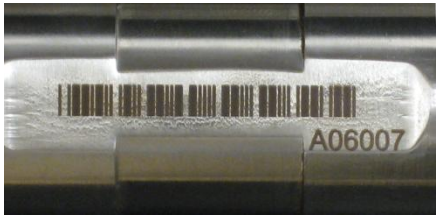
Indelible Marks and Traceability

Manufacturers need permanent marks on parts through which components can be easily traced from cradle to grave, and these part markings must be able to withstand the rigors of the manufacturing process. The marks also must be in a format that can instantly validate parts, such as with human readable and vision-readable UID 2-D markings by which any component's history can easily be extracted with vision system scanners.

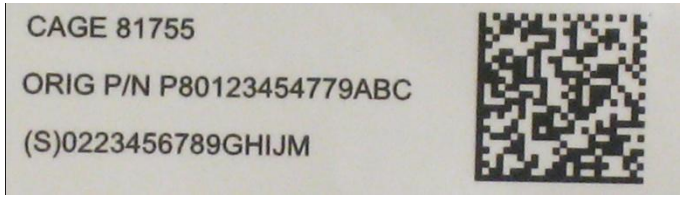
2-D and 1-D Barcodes

Laser marking provides the capability to mark a wide variety of machine readable codes for traceability purposes.

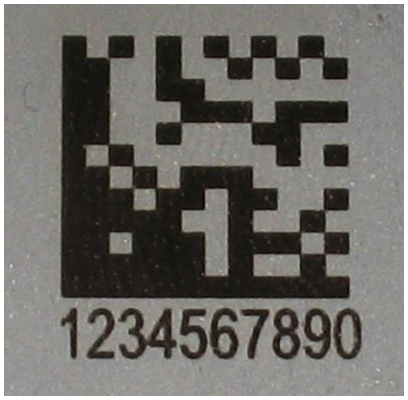
2-D Data Matrix



Multiple 1-D Barcode formats



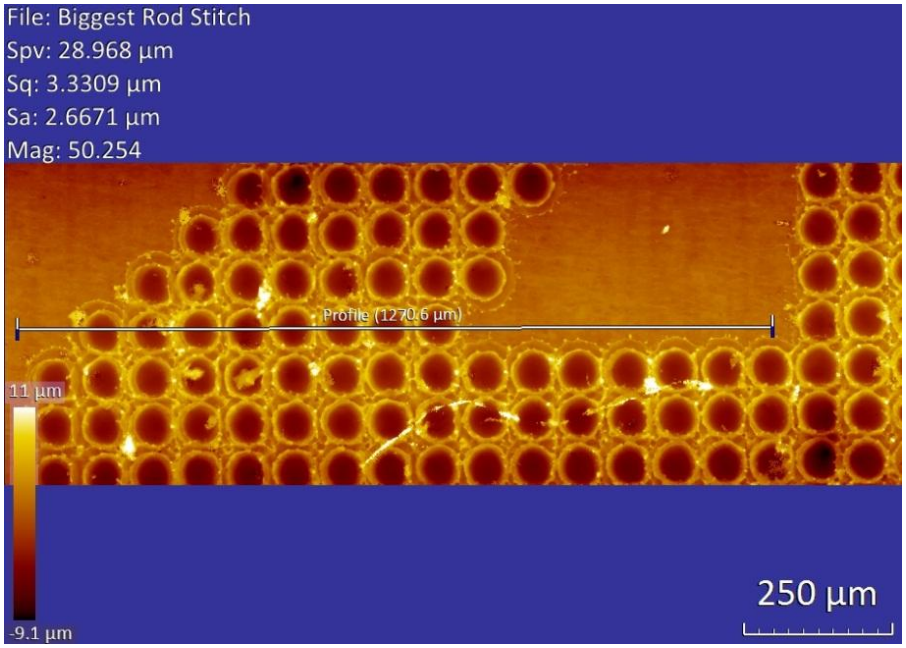
UID – Government/Military

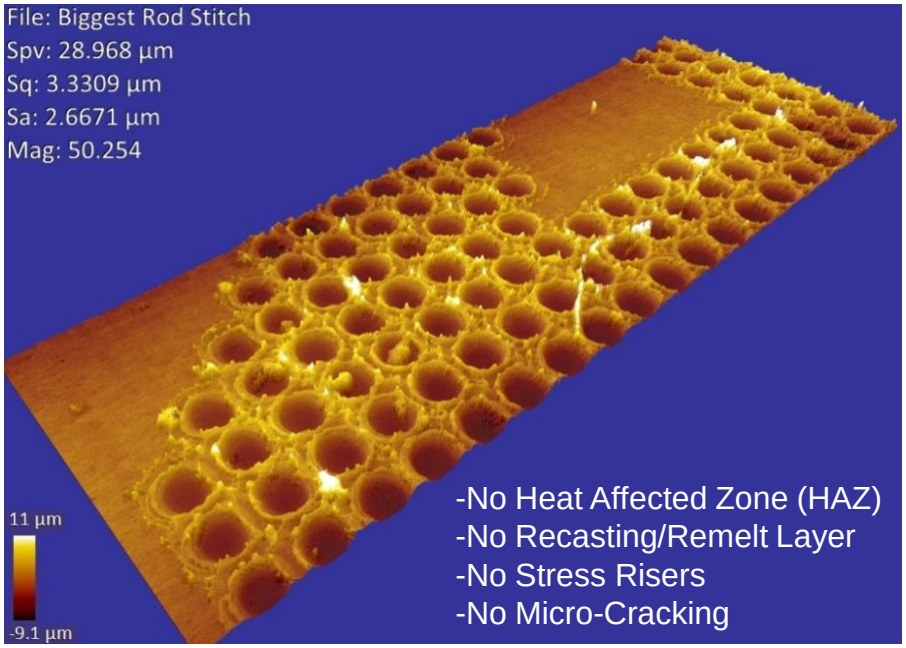


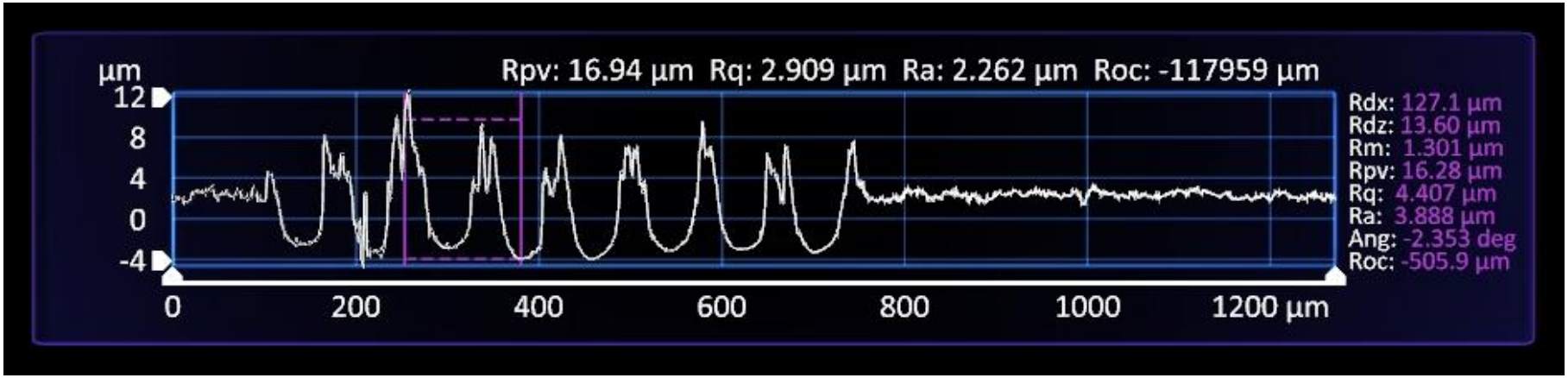
UDI/GS1 – Medical Device

QR Code

Advantages of Laser Marking – Direct Part | Non Impact Marking







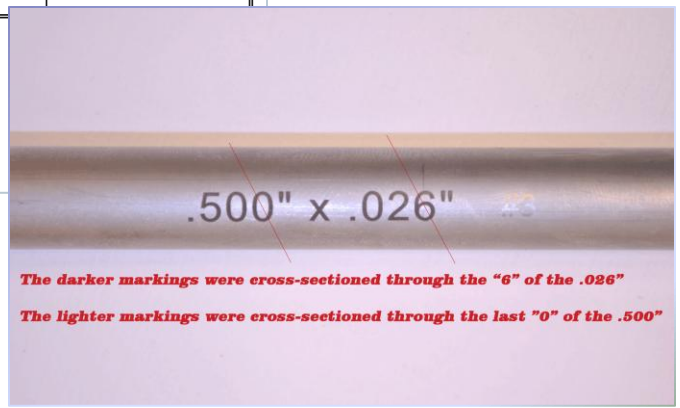
Advantages of Laser Marking – Direct Part | Non Impact Marking

METALLURGICAL EXAM

Three laser marked tubes were received for metallurgical analysis. Each tube was sectioned through a light and dark marked number and metallographically prepared. The samples were then examined for surface irregularities that were caused by marking, remelt layer, and a radius measurement was performed.

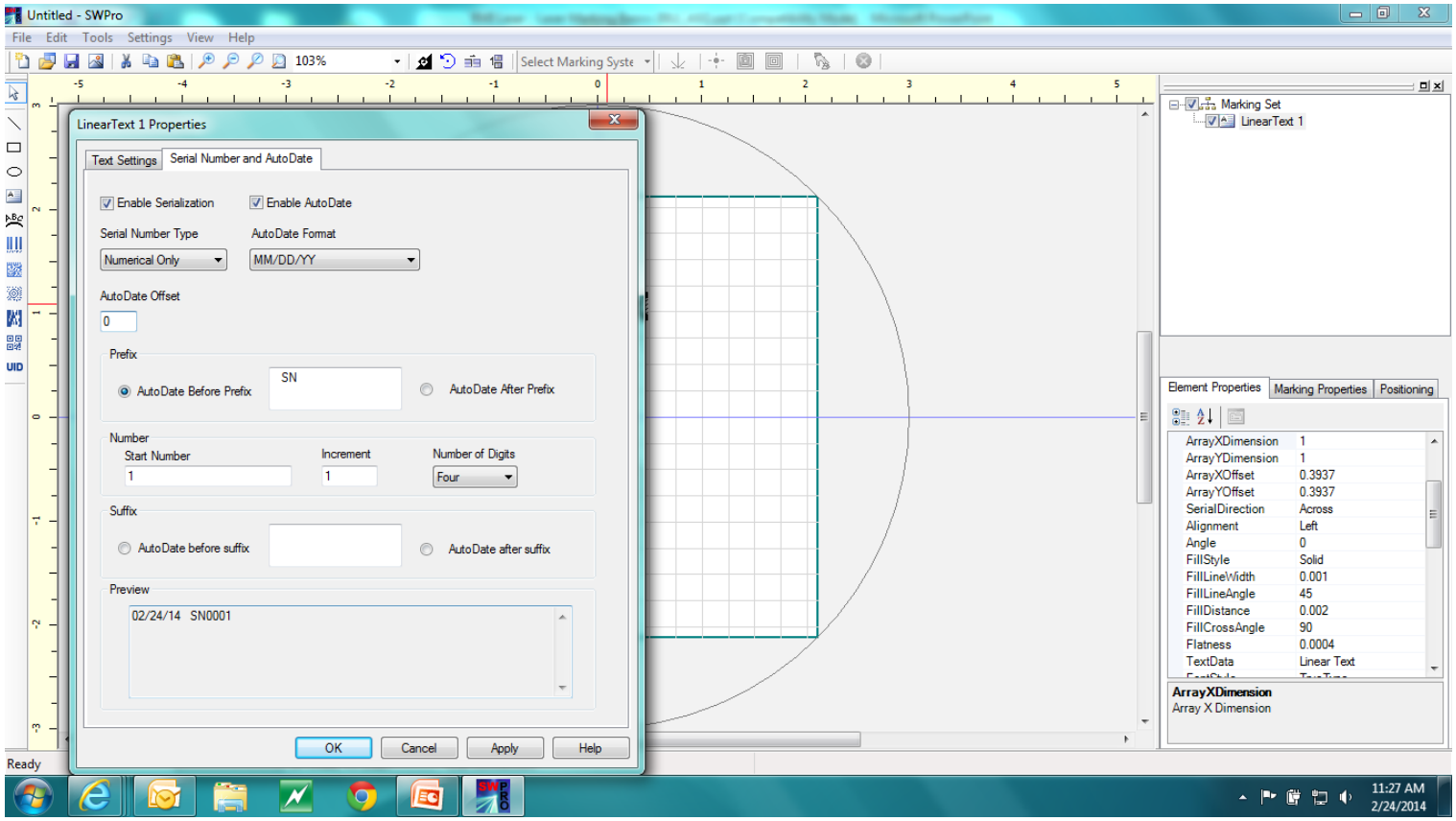
Laboratory Number	Surface Irregularity (in.)			Remelt Layer Max. Depth (in.) [1]	Radius	Customer ID
	Predominant	Maximum	Minimum			
6412-1MET1	<0.0001	<0.0001	0.0002	<0.0001	N/A	UM-1 Light
6412-1MET2	0.0002	0.0003	0.0005	0.0001	0.00017	UM-1 Dark
6412-2MET1	0.0002	0.0002	0.0003	<0.0001	0.00027	U-20 Light
6412-2MET2	0.0005	0.0004	0.0006	0.0002	0.00029	U-20 Dark
6412-3MET1	0.0008	0.0009	0.0013	0.0006	0.00090	UF-30 Light
6412-3MET2	0.0005	0.0012	0.0018	0.0008	0.00035	UF-30 Dark

Etchant: 1% HF
Magnification: 400x and 1000x
Method(s): PWA E-54 (2007)
[1] Remelt depth includes any heat affected area adjacent to recast material.

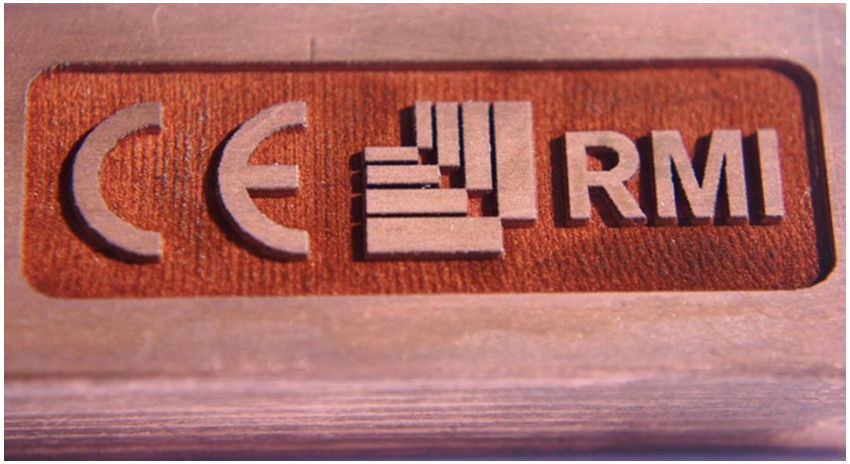


Auto Serialization/Date & Time Coding

RMI Laser's Software has the capability to do Auto Serialization and Date and Time Coding to prevent keying errors from operators.



Depth Control



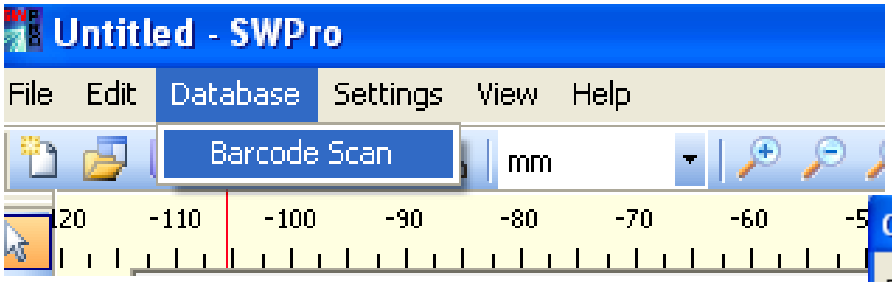
Deep Engraving

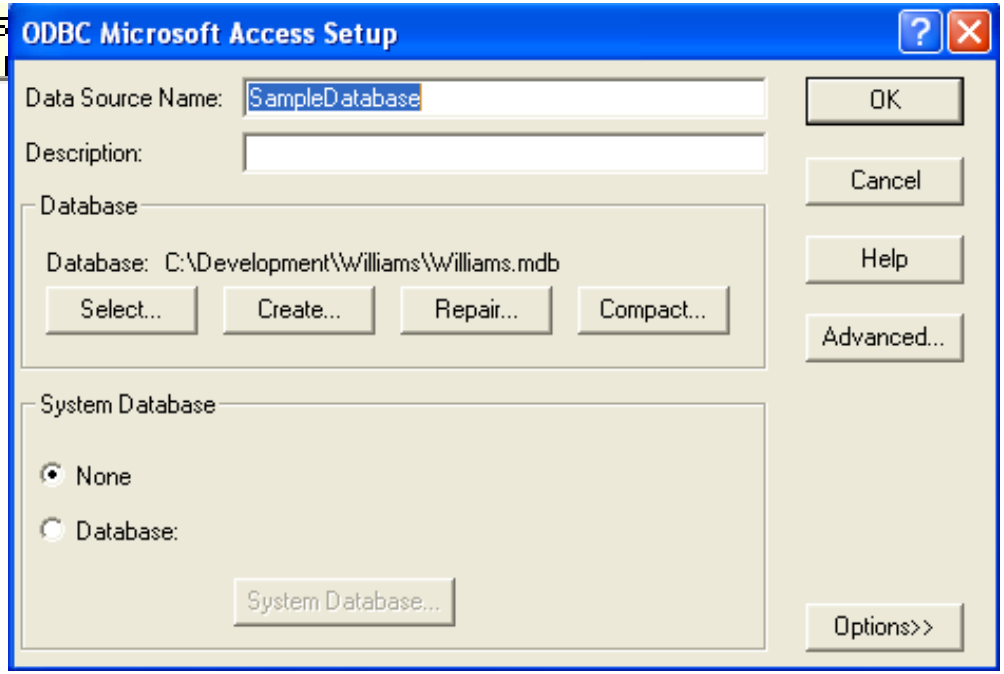
Deep Engraving on Hard Anodized

Anneal

Database connectivity and Integration

RMI Laser Software Engineers can customize software to accommodate Database pulling of marking data, storage of serial numbers, etc. The lasers can easily be integrated into automated production lines.





Ensure Accurate Data Entry:

- Scanning of Work Order/Traveler
  - Eliminates Operator “Fat-Fingering”
- Serial Number Duplicate Checking
- Failed Part Identification

THANK YOU

QUESTIONS & COMMENTS