Advances in Intense Pulsed Light Solutions For Display Manufacturing

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Talk Outline

- Introduction to Pulsed Light
- Applications in Display
- UV Curing Applications
- Printed Electronics
- Tools Available for R&D
- Indexed Production Systems

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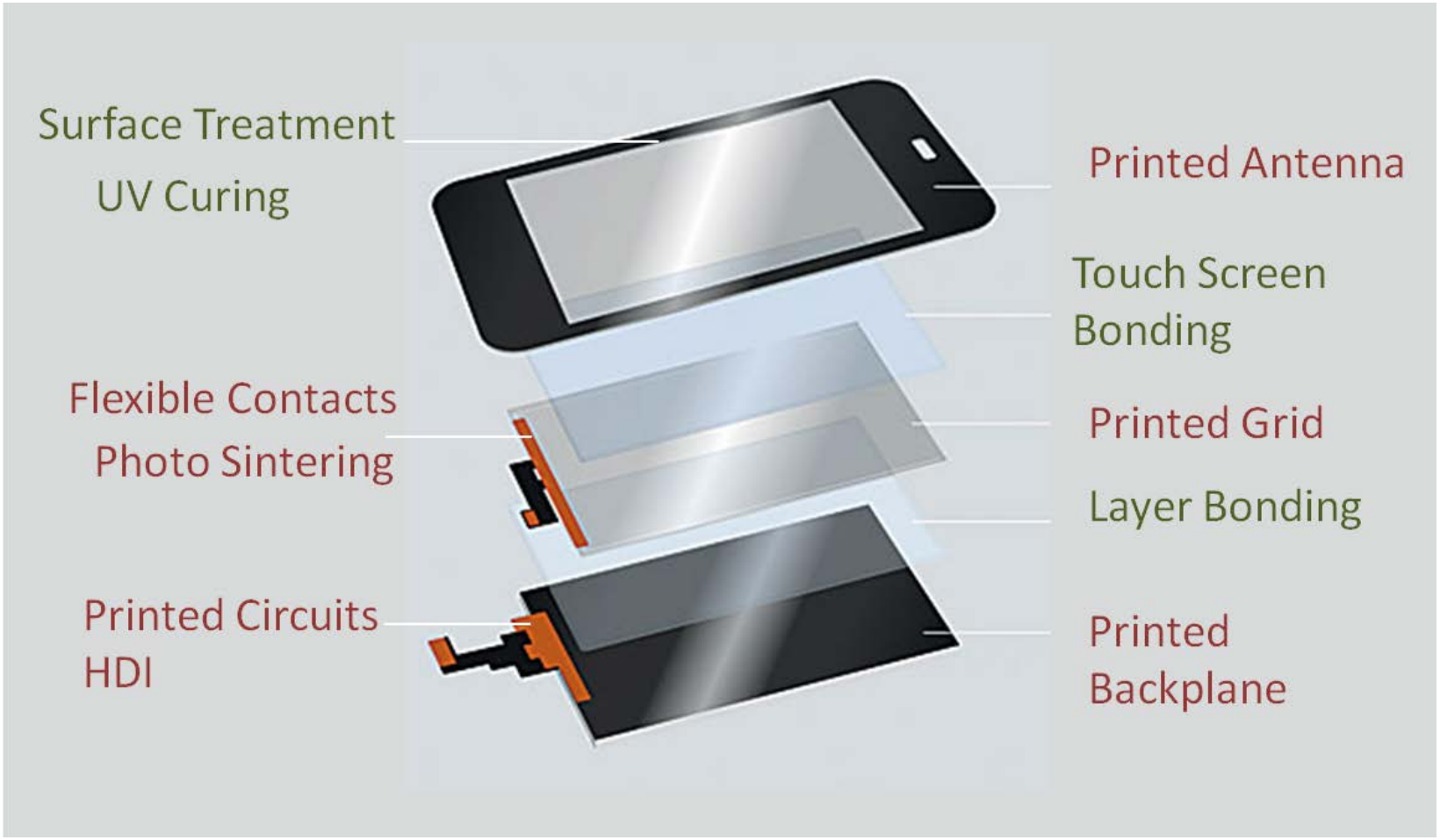
Potential Applications for Intense Pulsed Light in Displays



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UV Curing Application

- Most Famous Case Optical Disks
  - Optical Disk Manufacture
  - Nearly all Blue Ray Disk use Pulsed light for Manufacturing
  - The process requires intense puled UV light and uniform cure.
  - No temperature rise in substrate to avoid warping
  - Custom designed uniform Light Sources
- UV Curing of Special coating on Lenses
  - Optical transmissivity require chemical reactions outside the visible spectrum (i.e. UV)
  - Cant use Lasers to produce Large area uniform Coatings

Optical Disk and a special UV Lamp for Curing

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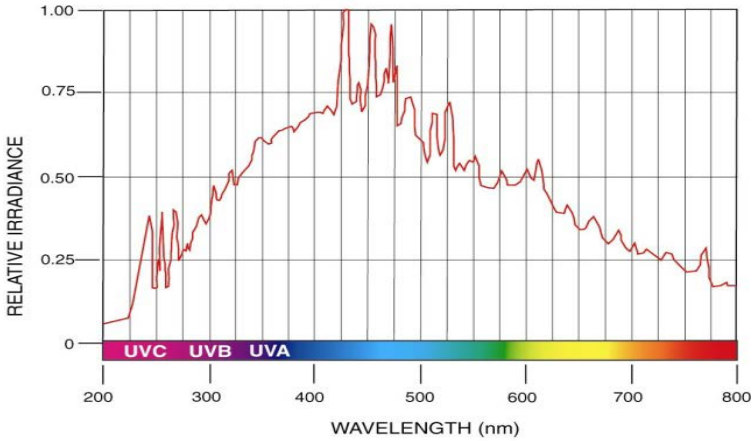
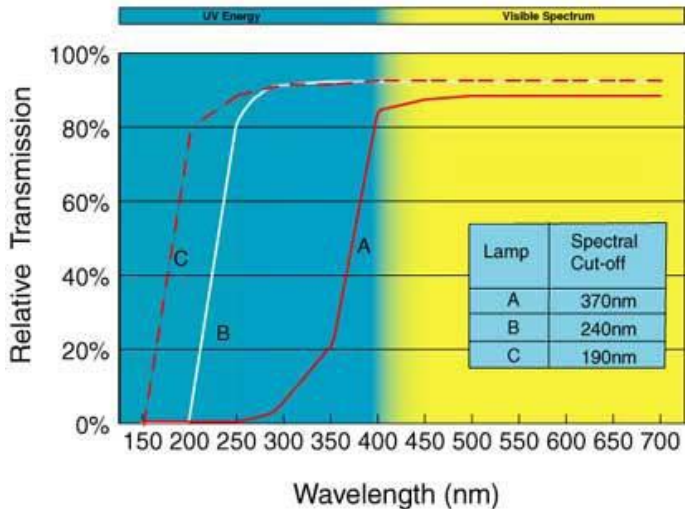
Flash Lamps

- Xenon flash lamps have a broad spectrum of Light from deep UV to IR.
- Typically used for Curing and Sterilization where high photon energy is required
- When Xenon gas is broken down due to a high energy field it goes from being an insulator to a conductor
- Excitation and recombination of ions within the arc plasma creates light.
- The envelope used can determine the spectral content of the lamp
- Lamps can explode due to excess energy through lamp
  - Typically operate at 10% of explosion energy





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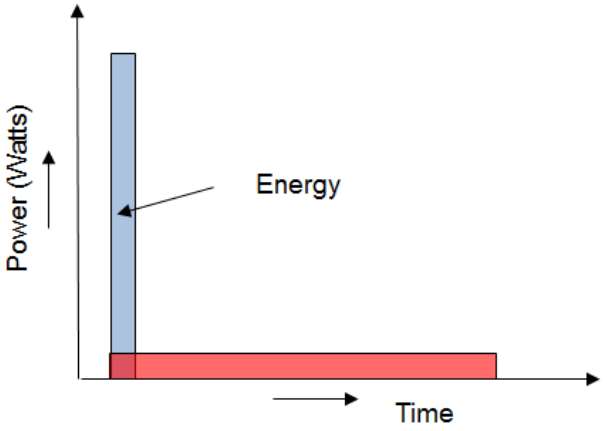
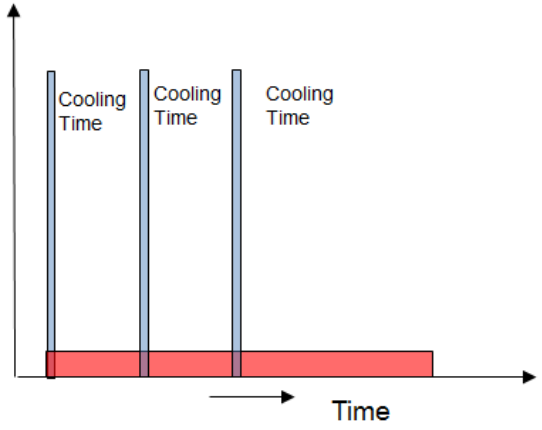
Pulsed vs. Continuous

- If we try to expend 100 Joules of energy we can do it in two ways
  - 10 Watt lamp for 10 Seconds or
  - 1 Megawatt pulse for 1 micro second.
- Continuous systems like mercury or halogen lamps cannot deliver these kinds of peak power.
- High peak power means the system is more efficient at delivering useful energy
- Intensity attenuates as it penetrates into a material so peak power phenomenon allows for deeper penetration depths
- Shorter pulse duration means that the process can take place quicker
- Pulsed is instant on-off. It is harder to do that with continuous systems
- Pulsed systems can be frequency adjusted to allow time for cooling





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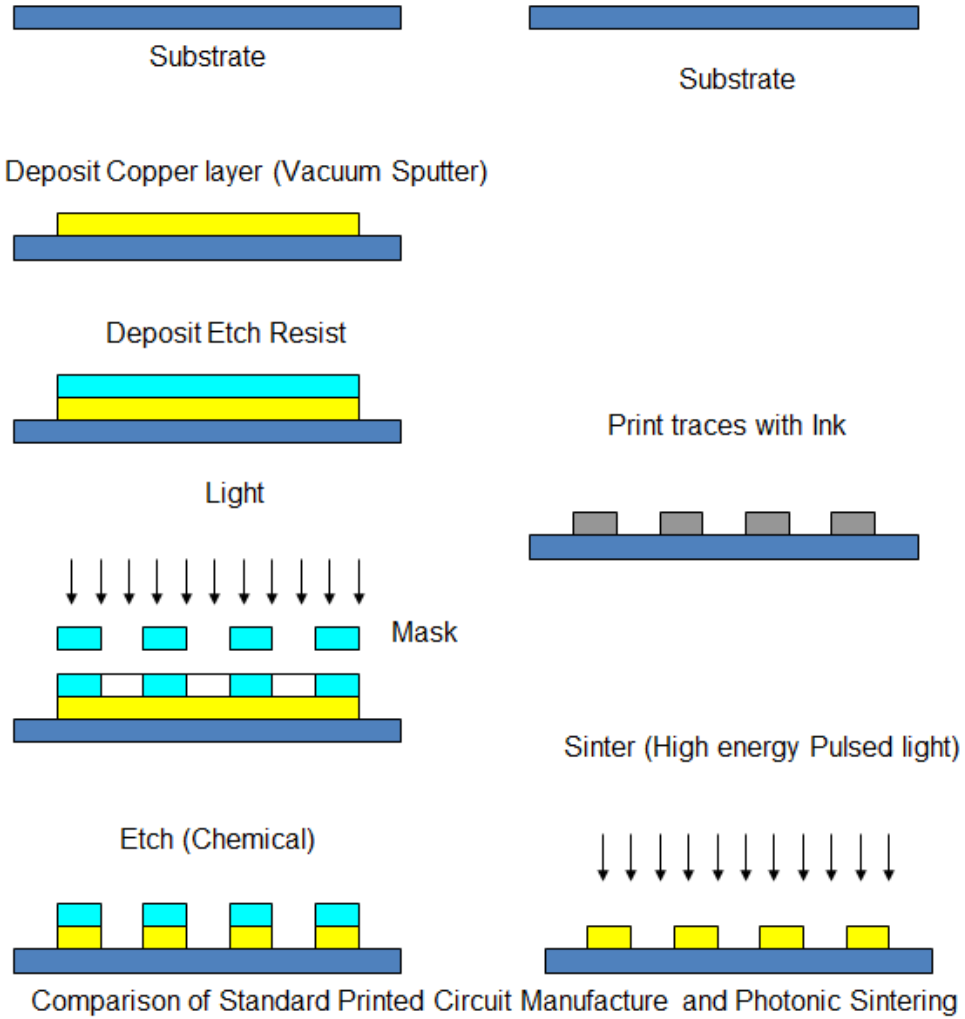
Current Printed Circuit Process

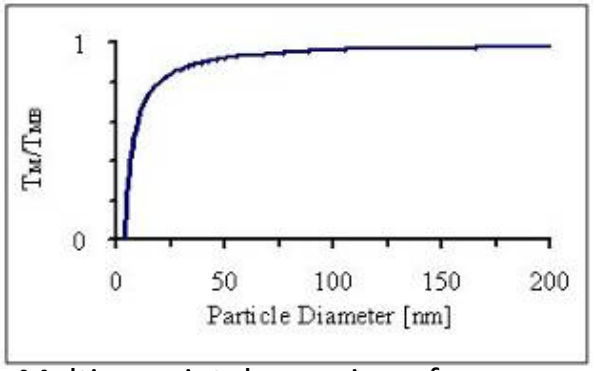
- Current process for printed electronic system requires multiple process steps
- They do not lend themselves to Reel-to-reel Systems
  - Flexible substrates
  - Low Temperature Substrates
  - Complex steps
- A simpler process would be to print conductive traces and cure to form conductive traces



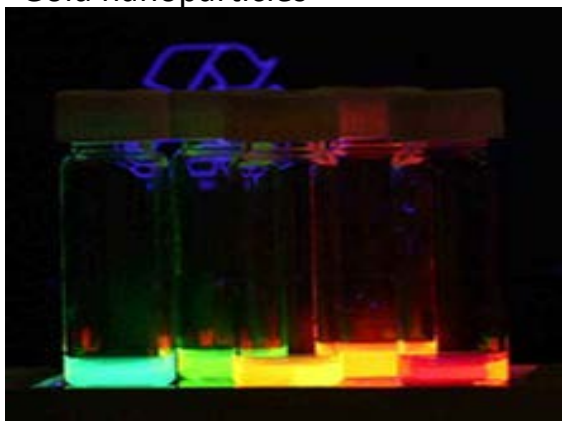
Comparison of Standard Printed Circuit Manufacture and Photonic Sintering

Photonic Sintering Basic

- Low temperature sintering of metal inks are possible because when particles become small their melting point is reduced. This phenomenon is called “Melting Point Depression”
- When particles become small their absorption characteristics change
- Nanotechnology is where particles are in the range of 1 to 100nm in size and it is at this particle size that these special effects take place
- Nano conductive inks can absorb light and sinter at a low temperature.
- Once sintered they behave like bulk material



Melting point depression of Gold nanoparticles



Quantum Dots are same material but with different size which changes color

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XENON Corp- An Introduction

- We manufacture High Energy Pulsed Light systems for industrial applications.
- We began in 1964 developing high energy pulsed lamps for Laser Pumping.
- We have 50 years of experience with our core technology of pulse light.
- Over 3,000 pulsed light systems worldwide on Industrial Production lines.
- Our Markets Include:
  - Photonic Sintering
  - Optical Disk Manufacture
  - Pulsed UV Sterilization
  - Display
  - Surface Treatment
- We manufacture in the U.S.A. our own Lamps and Electronic systems
- We build “the engine” that integrates into industrial systems that need to run 24/7
- Pulsed light is our expertise we pick up where other sources cannot compete in terms of energy, peak power and low temperature

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Thin Films for HDI

- Current process for creating thin copper films uses Vacuum Sputtering
- This is not applicable for In-line Roll to Roll Process
- A process alternative is to use Slot dye Copper ink and Photo Sinter

Etch

Plate

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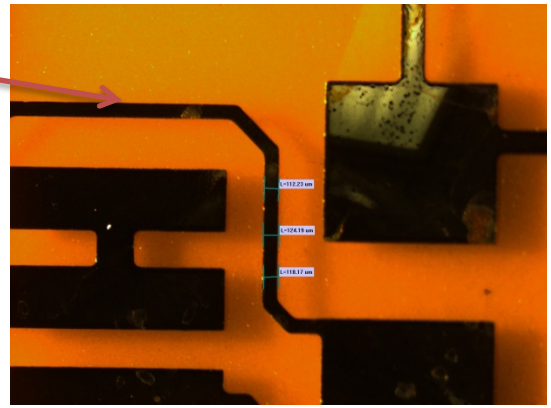
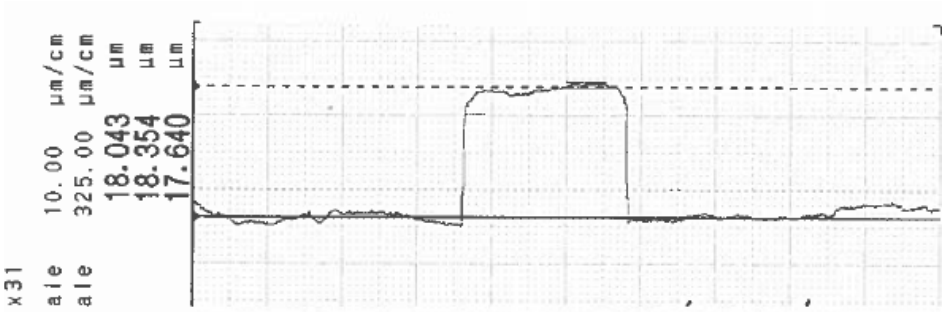
Advantages of Copper Sintering Process

- Coating with IM's nano copper solution will achieve 0.5-2um thickness copper foil over polyimide, single or double sided.
- Ultra thin FCCL can be used by traditional plating and etching process to achieve thin lines.
- It has smooth copper/polyimide interface, easy to make and low cost.
- Porosity of Sintered copper makes it easy to etch for better profilometry

<100um





intrinsiq materials

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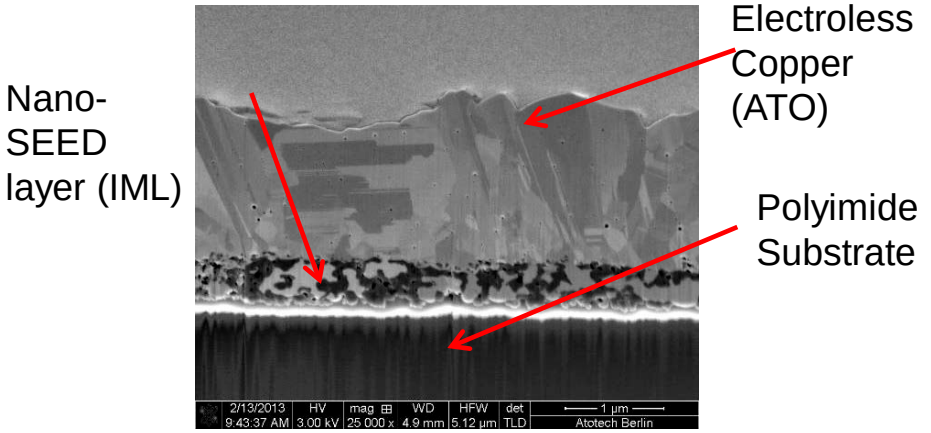
Advantages Continued

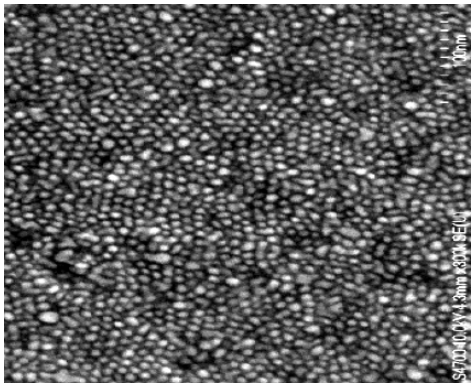
- Uses Minimal Nano-ink for lower cost
- Uses Standard Processes
- Double Side Possible
- Smooth interface between copper foil and polyimide, help signal integrity for high speed applications.



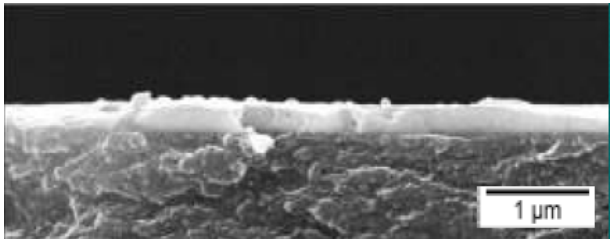
Feature	Advantage	Benefit
Ultra thin copper layer can be under 1 µm	Can create features smaller than industry standard using standard PCB technology	Increased circuit density and functionality
Thin film can replace lamination step	Reduced process steps, cycle time, and material waste	Lower cost, easier handling, and added functionality
Highly electrically and thermally conductive copper film	Equivalent performance to laminated foil	High performance
Deposited through conventional printers (inkjet, screen printers)	Minimal re-tooling	Low cost
Airhandleable, no vacuum or environmental controls needed	Operates in an open environment	Lower cost & smaller footprint
Photonic sinter, lower temperature	Can use temperature sensitive substrate such as paper, plastic	Added flexibility and functionality, with lower cost

Silver Sintering

- Silver inks are well suited to photonic sintering
  - Both silver and its oxide are conductive
  - Formulation and manufacture of silver nano inks are easier and more prevalent
  - Their operational window is large
  - Their size can be tightly controlled
  - They can show improvement in their functionality with multiple pulses (contrary to the concept of nanoparticle advantage)



SEM of Silver Nano particle
5-6nm in size



AG Film on PET
After sintering

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Advantages of Photonic Sintering

- Conventional method of sintering conductive inks is to use low temperature ovens
- The time to achieve sintering is many minutes and not suited to Roll to Roll process
- Photonic sintering can take place in fractions of seconds
- Photonic sintering is a non contact process
- It requires no additional chemicals or special environment
- It is a low temperature process allowing use of low temperature flexible substrates like paper and PET
- It is easy to configure for different ink types, substrates and printing process.
- It can be fitted inline with an existing process without taking the space required for ovens or off-line solutions.

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S-5100 Wide Web R2R

- First true Wide width Photonic Sintering System
- Multiple 50in Lamp housing with 1m wide web capability (system shown can drive 4 50in Lamps)
- Touchscreen display for precise control of process parameters with tachometer speed control.
- Unprecedented uniformity along length +-5%
- High power 5J/cm^2
- Modular design for scalability

Modular Units for Integrators

- Automation Proven
- Flexible Integration
- High Volume Pricing
- Over 3,000 Systems Online

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Thank you

- Questions and Comments

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