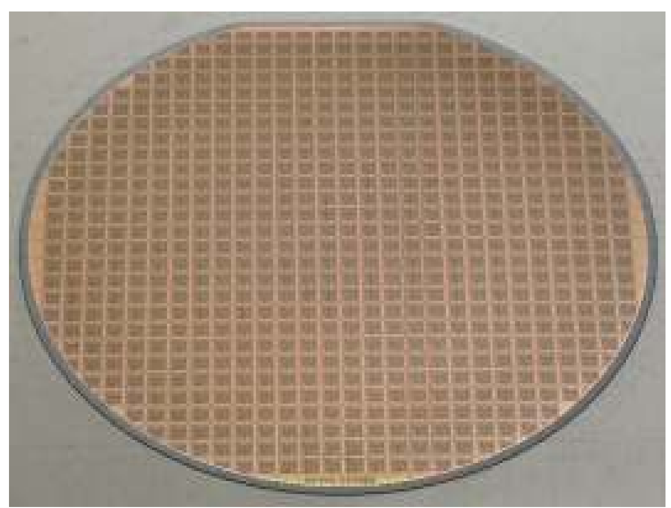
Innovative Laser Systems

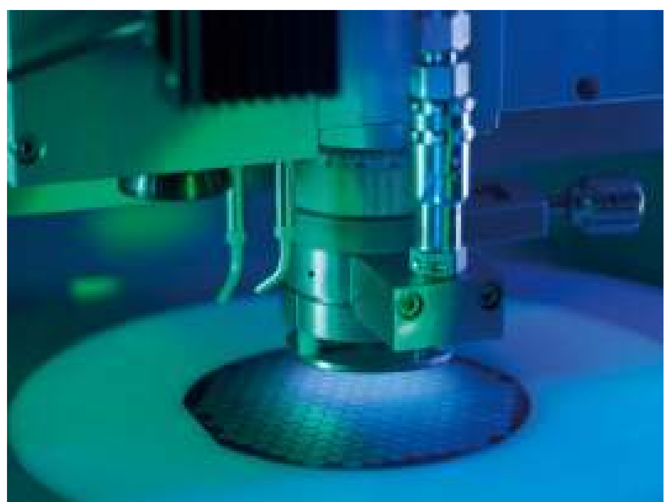
Compound Semiconductors

Synova Confidential

Agenda

- Synova History
- Laser MicroJet Technology (LMJ®)
- Market and Technology Overview
- Application Examples
- Solutions and Benefits





Partnering for the future

- Holland Private Equity (HPE) has invested 20M CHF in October 2011 for a minority stake in Synova S.A.

- Solid multiyear foundation in place:
  - To strenghten our Supply Chain and partner with Strategic Suppliers
  - Increase our Global Infrastructure for Sales and Support
  - Add Micro Machining Centers in South Korea, the USA and China
  - Invest in Strategic Developments to exceed our Customer’s actual requirements and future expectations
  - Strengthen our core competencies

History

- Synova S.A. has shipped over 100 Systems since 1997 across the World
- Our Innovative Laser Systems and unique technology has been recognized by several awards

Le laser guidé par jet d'eau fait des miracles

“Water jet guided laser performs miracles”

Dem klassischen Laser meilenweit voraus

“Miles away from conventional laser”

Going Where No Other Laser Can Go

“Going where no other laser can go”

Global Infrastructure

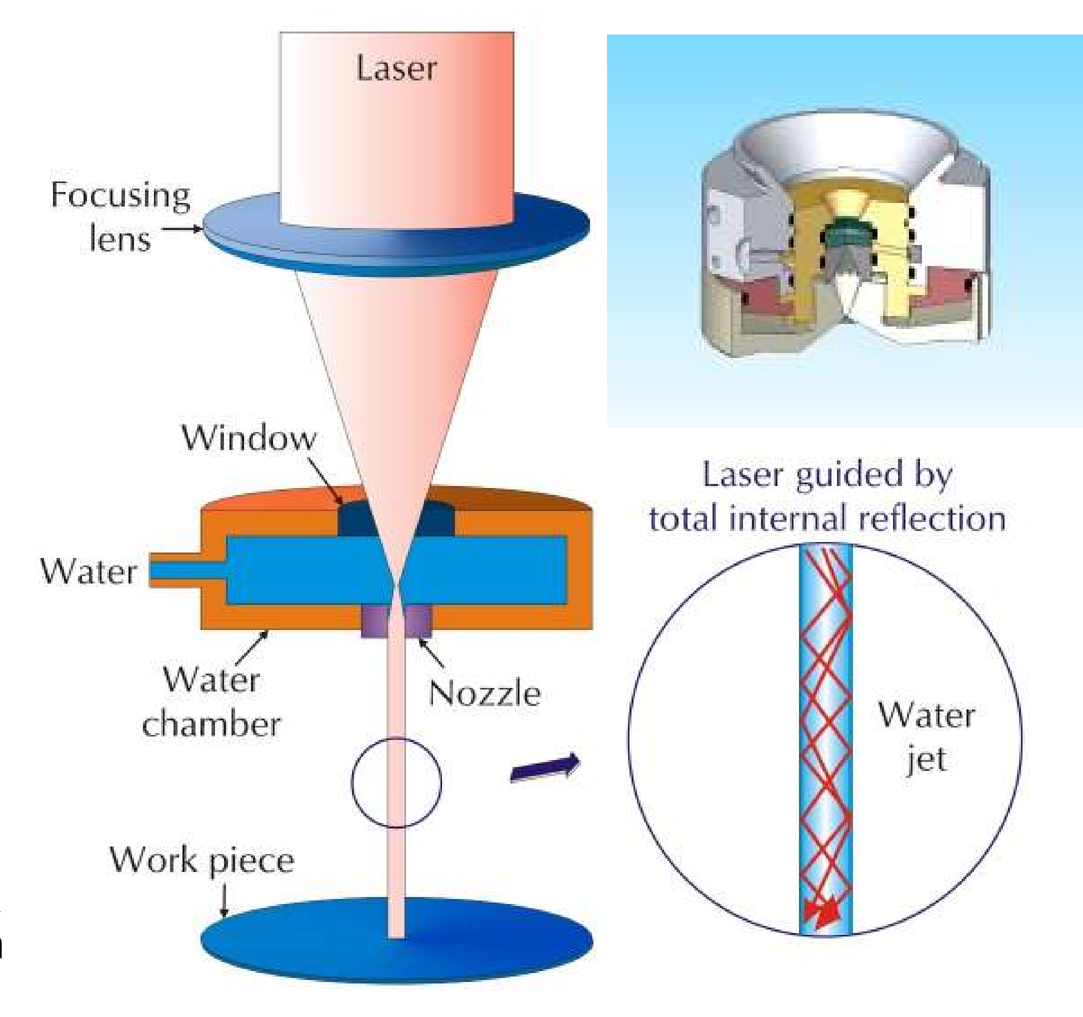
Synova Worlwide

United Kingdom
Germany
France
Italy
Lausanne, Switzerland
Fremont Synova-USA
Israel
Korea
Japan
Taiwan
China
India
Malaysia Singapore

- Headquarters
- Sales
- Distributor
- MMC (Micro-Machining Center)

Laser Microjet Technology - a simple principle

- **A Revolution in Micromachining**
- For the first time ever, it is possible to combine the advantages of both water and laser cutting in one operation. Utilizing the difference in the refractive indices of air and water, the technology behind Laser MicroJet® creates a laser beam that is completely reflected at the air-water interface.
- The laser is, therefore, entirely contained within the water jet as a parallel beam, similar in principle to an optical fiber.



Technology advantages

The LMJ solves all drawbacks of conventional lasers

Conventional Laser	Laser MicroJet®
Requires precise focus adjustment	No focus adjustment required, non-flat surfaces are not an issue, 3D cutting possible, variable cutting depth of up to several cm
Conical laser beam leaves non-parallel kerf walls	Cylindrical beam results in parallel kerf walls, consistent high quality cutting
Limitations in cutting aspect ratio	High aspect ratio, very small kerf widths (< 30 µm possible), minimising material loss, with simultaneous deep cuts possible
Heat affected zone	Water-cooling process avoids thermal damage and material change, high fracture strength is maintained
Particle deposition	A thin water film eliminates particle deposition and contamination, no surface protection layer required
Inefficient material removal leaves burrs	The high kinetic energy of the water jet expels molten material, no burrs form

Compound Semiconductors (CS)

CS material substrate applications segmentation

CS Material substrates

InP
Bulk GaN
SC GaAs
Sapphire
SC SiC
SI SiC
InP
SI GaAs

Opto. Laser
Opto. LED
Power electronics
RF electronics

Data storage
Displays laser TV & screens
Optical Telecom.

Laser Disk
DVD
BluRay
HD-DVD

Personal TV
Movie theatre

Power supplies
UPS

Hybrid automotive

Mobile phones
WiFi
WiMAX

3G/WiMAX base stations
Defense
VSAT, SatCom

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Executive Summary

CS Market - Overall

- The global market for compound semiconductors is expected to increase from $16.0 billion in 2007 to $33.7 billion by the end of 2012, a compound annual growth rate (CAGR) of 17.3%.
- Wireless electronic devices have the largest share of the market, generating $5.7 billion in 2007. This is expected to reach $9.6 billion in 2012, for a CAGR of 10.8%.
- Solar cell applications are expected to grow at a CAGR of 85.0%, from $9.0 million in 2007 to an estimated $2.3 billion in 2012.

SUMMARY TABLE
GLOBAL COMPOUND SEMICONDUCTOR MARKET VALUE, THROUGH 2012
($ BILLION)

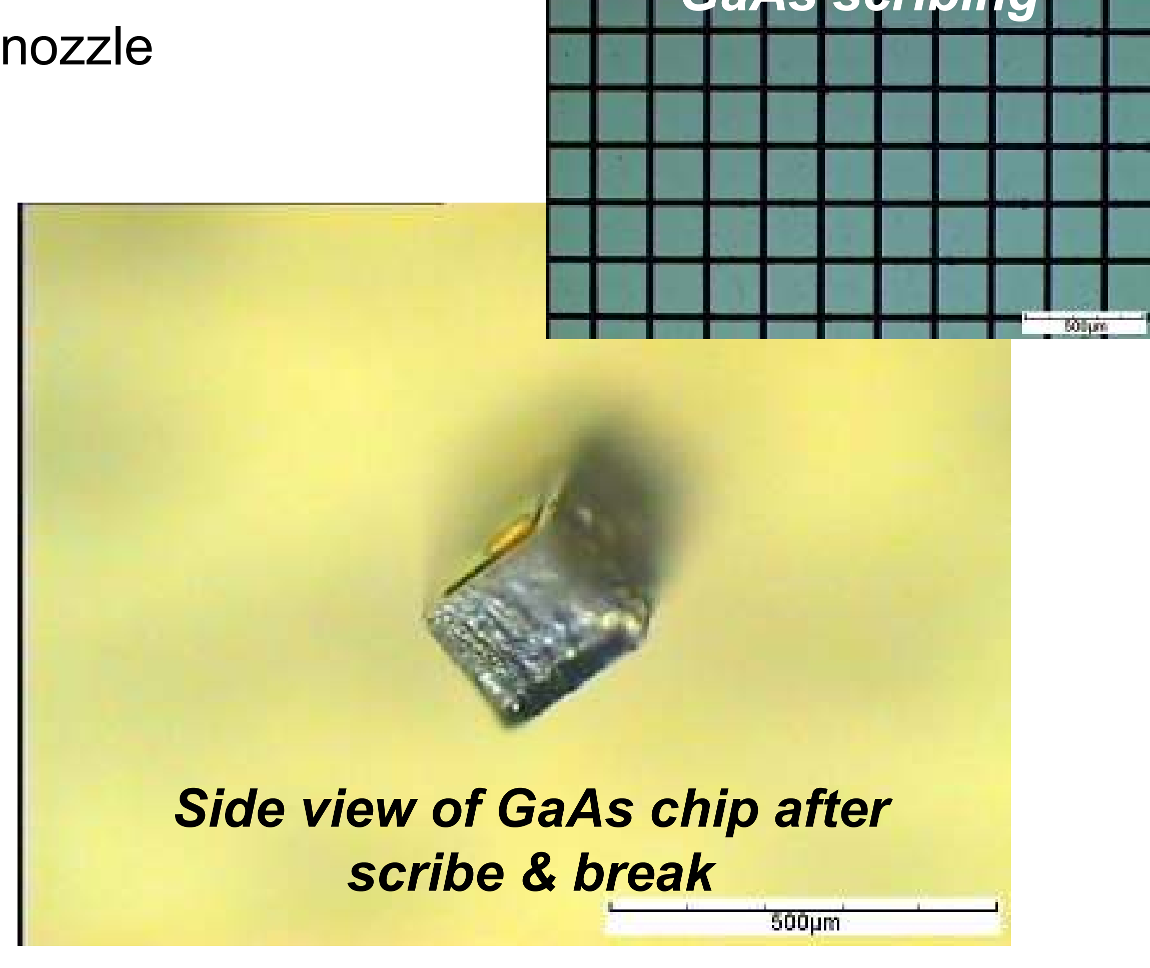
	2006	2007	2012	CAGR% 2007-2012
Wireless electronic devices	5.86	5.72	9.55	10.8
Optical data storage	1.49	1.65	3.43	15.8
Fiber optics communications	1.15	1.15	6.07	39.5
Illumination	1.63	1.90	2.33	4.2
Solar cells (ground)	0.01	0.09	1.95	85.0
New markets	0.00	0.90	4.00	34.8
Other	4.30	4.61	6.38	6.7
Total	14.44	16.02	33.71	17.3

Source:BCC Research

Report Code: SMC032C, Published: July 2008, Analyst: Andrew Zhalko-Tytarenko

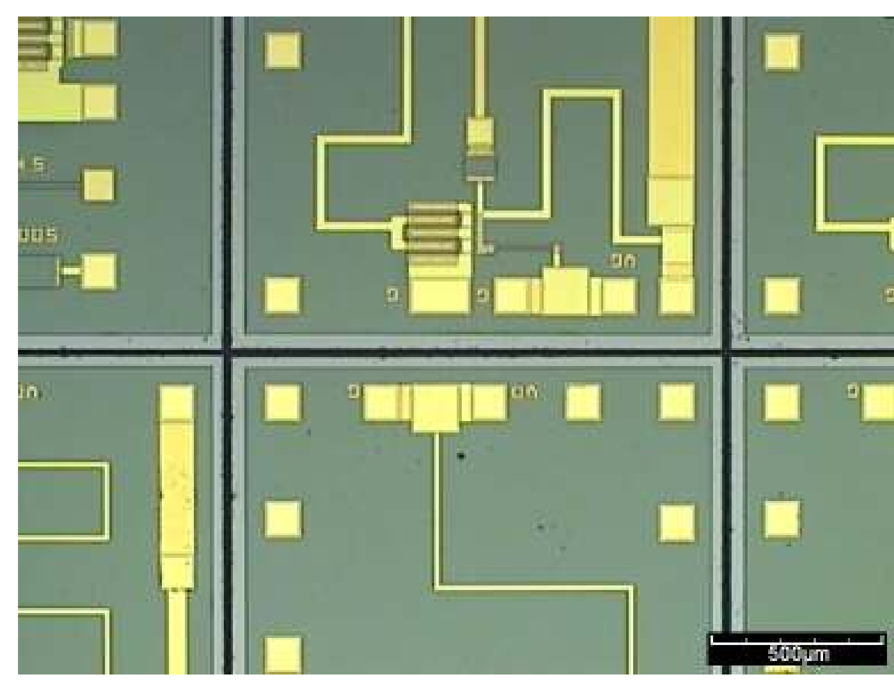
Application – GaAs Scribe & Break 0.2mm

- Best quality with infrared fibre laser
- Narrow street with 30µm nozzle
- Laser parameters:
  - Laser settings: 50kHz
  - Laser power: 20W
  - Speed: 100mm/s
  - 4 passes



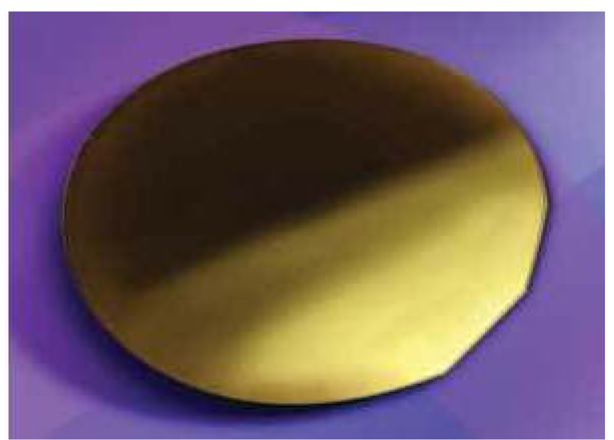
Application - GaAs Dicing (25 and 30 Micron Nozzle)

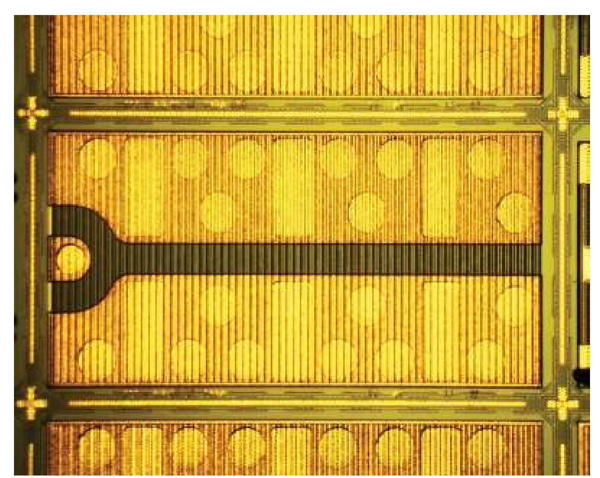
- Challenges with GaAs are the fragility of the material
- Our technology minimizes the impact of Thermal and Mechanical damages
- State of the art today is 25 Micron Nozzles in 40 Micron Streets



New Materials

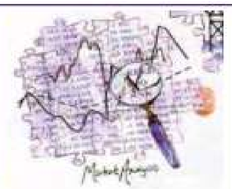
- New Wafer Materials
  - Gallium Nitride (GaN)
  - Silicon Carbide (SiC)
- Offers higher performance
  - Better Switching speed
  - Improved Power Efficiency





SiC and GaN

Main applications accessible to SiC and GaN
Specs / market data of today silicon devices



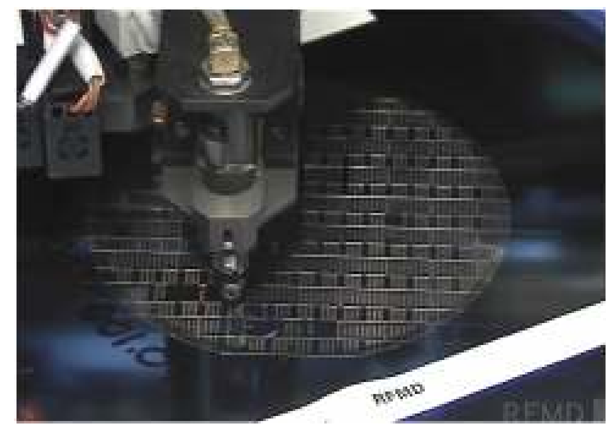
	Power supplies / PFC	UPS	HEV	Solar panel	Wind turbine	Industry Motor Drives	Energy Transport. Grid, Rail traction
Main devices	MOSFET Diodes	MOSFET IGBT Diodes	MOSFET IGBT Diodes	IGBT Diodes	IGBT Diodes	IGBT Diodes	GTO, Thyristor, IGBT PiN diode
Breakdown Voltage (V)	600 V	600 / 1200 V	650 V -> 900 V - > 1.2kV	600 V (90%) 1200 V (10%)	Today 690 V Trend: 3-4 kV	600 V to 1200 V	> 5 kV
Peek current (A) (for a single chip)	0.5 – 10 A	2 – 100 A	50 - 200 A	75 A	150 A	3 – 100 A	10 – 200 A
2008 volume (Munits)	MOS: 1,600 Diode: 1,600	IGBT: 800 Diode: 800	IGBT: 2.6 Diode: 2.6	IGBT: 12 Diode: 12	IGBT: 0.11 Diode: 0.11	IGBT: 25 Diode: 25	Wide range of specs / price
2008 ASP for a discrete device	Trans: $0.6 - $1 Diode: $0.3	Trans: $1.2 Diode: $0.6	Trans: $9 Diode: $5	IGBT: $8 Diode: $4	IGBT: $20 Diode: $8	IGBT: $8 Diode: $4	
2008 Si devices market ($M) (Discrete)	1,800	1,400	~ 40	150	< 3	~ 300	~ 110

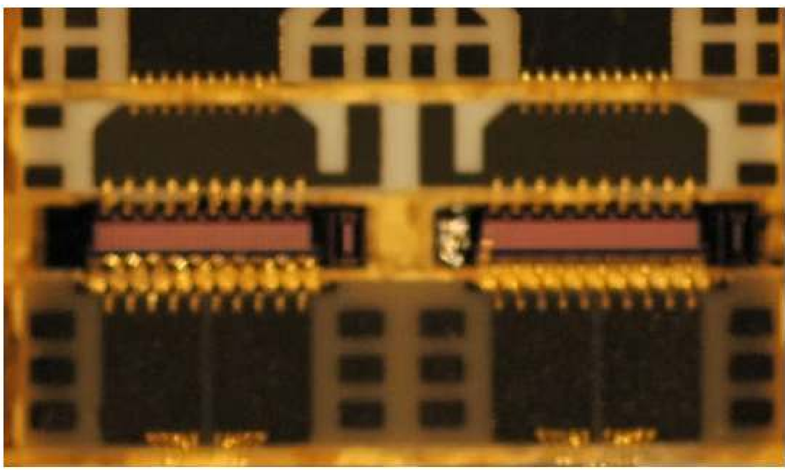
YOLE DEVELOPPEMENT

Total Available Market was $3.8B in 08 !!

Gallium Nitride

- GaN on SiC wafers
- Triquint Activity: Richardson TX
- RFMD activity
  - Uses Wafer Fab in Greensboro
  - Assembly in Broomfield, CO
- Skyworks also has GaN HEMT products





Features

- Advanced GaN HEMT and Heat Sink Technology
- Input Internally Matched to 50Ω
- 28V Operation, Output Power of 9W
- 30MHz to 512MHz Instantaneous Bandwidth
- Gain: 19dB
- Power Added Efficiency: 70%
- Large-Signal Models Available
- EAR99 export control

Applications

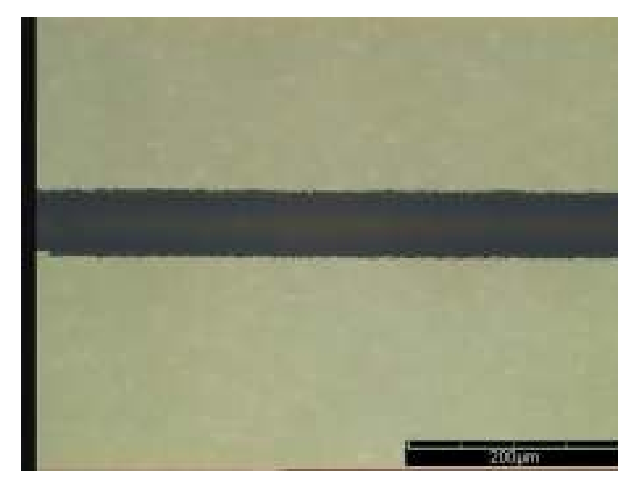
- Milcom, Public Mobile Radio
- Electronic Warfare
- Power Amplifier Stage for Commercial Wireless Infrastructure
- Civilian and Military Radar
- General Purpose Tx Amplification

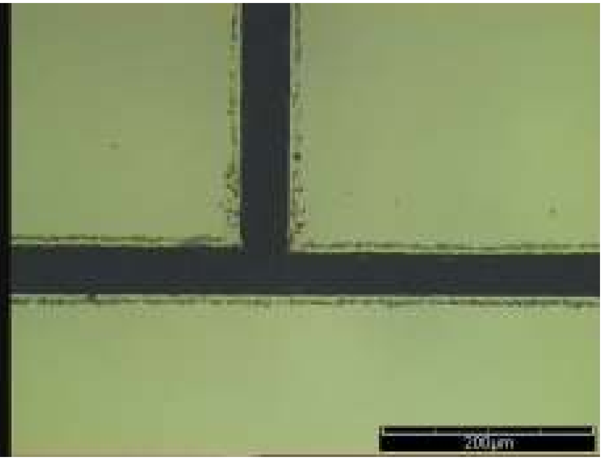
RFMD Picures & Product Specs

SiC

SAMPLE	Material	Blank silicon carbide wafers	
	Dimension	Shards of 2" wafers	*mm*
	Thickness	400	*µm*
	Quantity	3	*pcs*

MICROJET® PARAMETER	Nozzle diameter	40	*µm*
	MicroJet® diameter	34	*µm*
	Water pressure	300	*bar*
	Assist gas	He	
	Tape [1]	Lintec ADWILL 636	
LASER PARAMETER	Laser type	L101G	
	Wavelength	532	*nm*
	Pulse frequency	20	*kHz*
	Average power	19	*W*
CUTTING PARAMETER			
- "CUTS" [2]	Cutting speed	100	*mm/s*
	Number of passes	60	
	Overall speed	1.7	*mm/s*
	Process time full pattern ("cuts" only)	72	*min*
- "SUBCUTS"	Cutting speed	80	*mm/s*
	Number of passes	40	
	Overall speed	2	*mm/s*
	Process time full pattern ("subcuts")	7	*min*
PROCESS TIME [3]	**Total 4" pattern**	**79**	***min***
	Calculated on 2"	approx. 20	*min*





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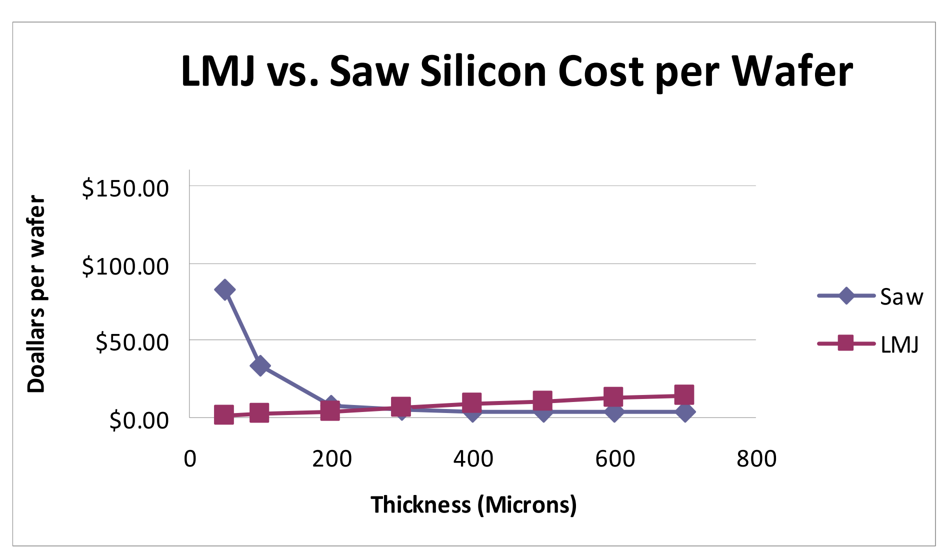
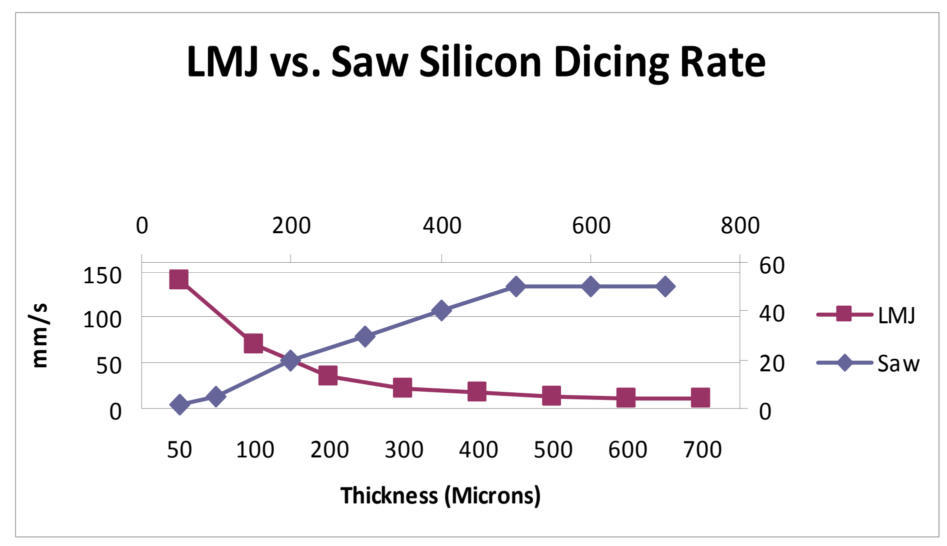
Advantages – Thin Silicon Wafers

	SAW	Laser	**LMJ**
Cost of Ownership	✘	✓	✓
Speed	✘	✓	✓
Edge quality	✘	✘	✓
Tool wear	✘	✓	✓
HAZ	✓	✘	✓
Flexibility	✘	✓	✓
Kerf width	✘	~	✓
Wide range of materials (SiC, GaN)	✘	✓	✓

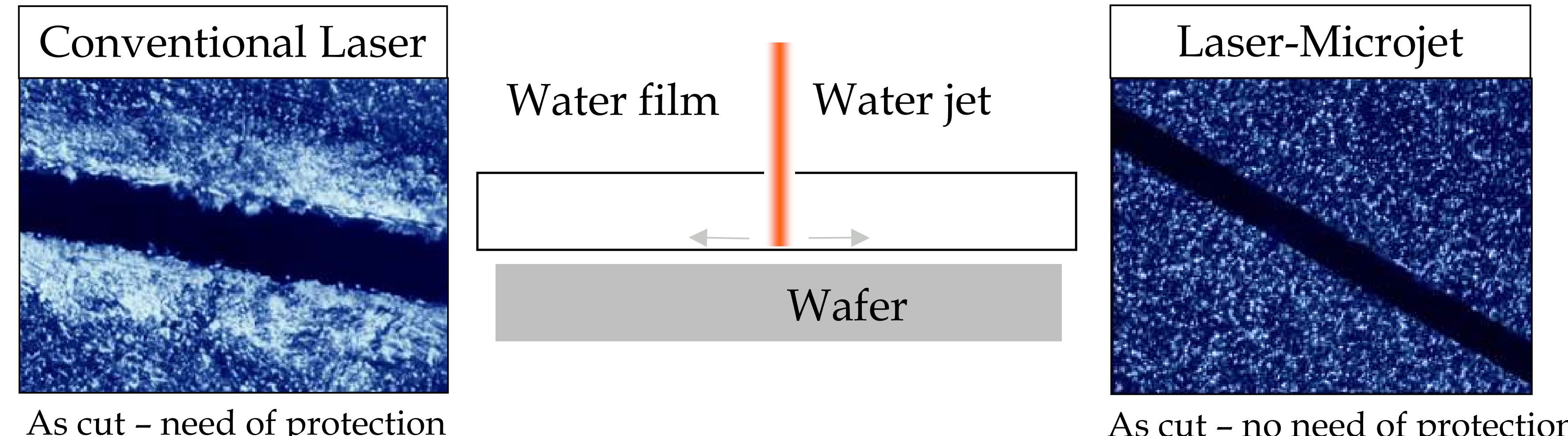
Benefits for Thin Wafers

- Mechanical Saws need to slow down dramatically for Thin Wafers. Tool costs also increase. They cannot do Wafers with Flat Notches.
- Dry Lasers need larger Kerfs because of the Heat Affected Zones
- It is possible to do Edge Cutting and Dicing on same machine





Clean and No Thermal Damage Laser Cutting



As cut – need of protection

As cut – no need of protection

Enables to get clean post cut surface
Ensures Higher Break Strength

Summary

- The Laser Microjet technology improves the quality of the cut:
  - Less Mechanical and Thermal stresses than the Mechanical saw or the Dry laser
- Synova can also reduce and even eliminate the post cleaning operations
- Synova can be much faster for certain applications
  - Hard Materials like Silicon Carbide
  - Thin Wafers