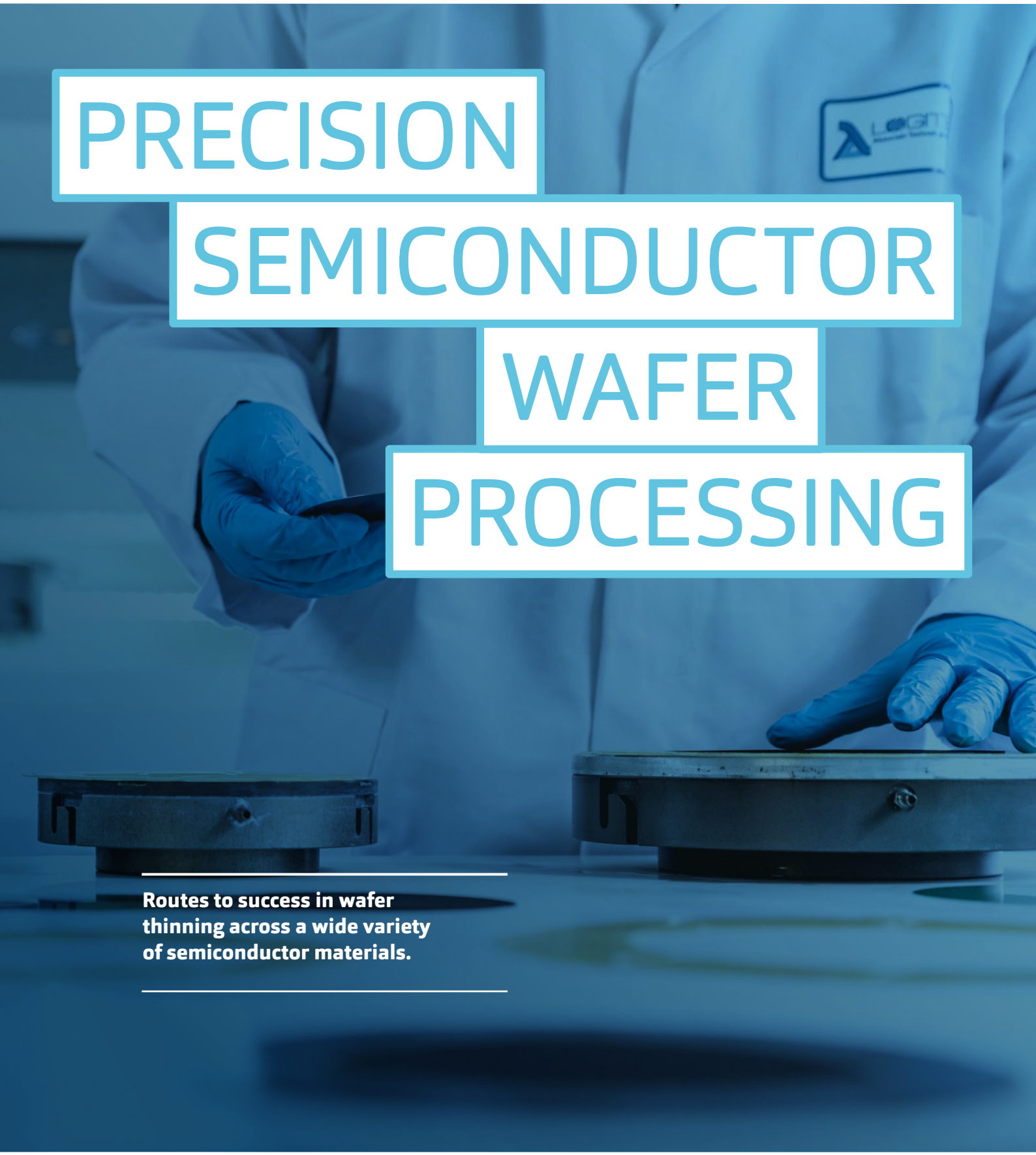

# PRECISION SEMICONDUCTOR WAFER PROCESSING

**Routes to success in wafer thinning across a wide variety of semiconductor materials.**

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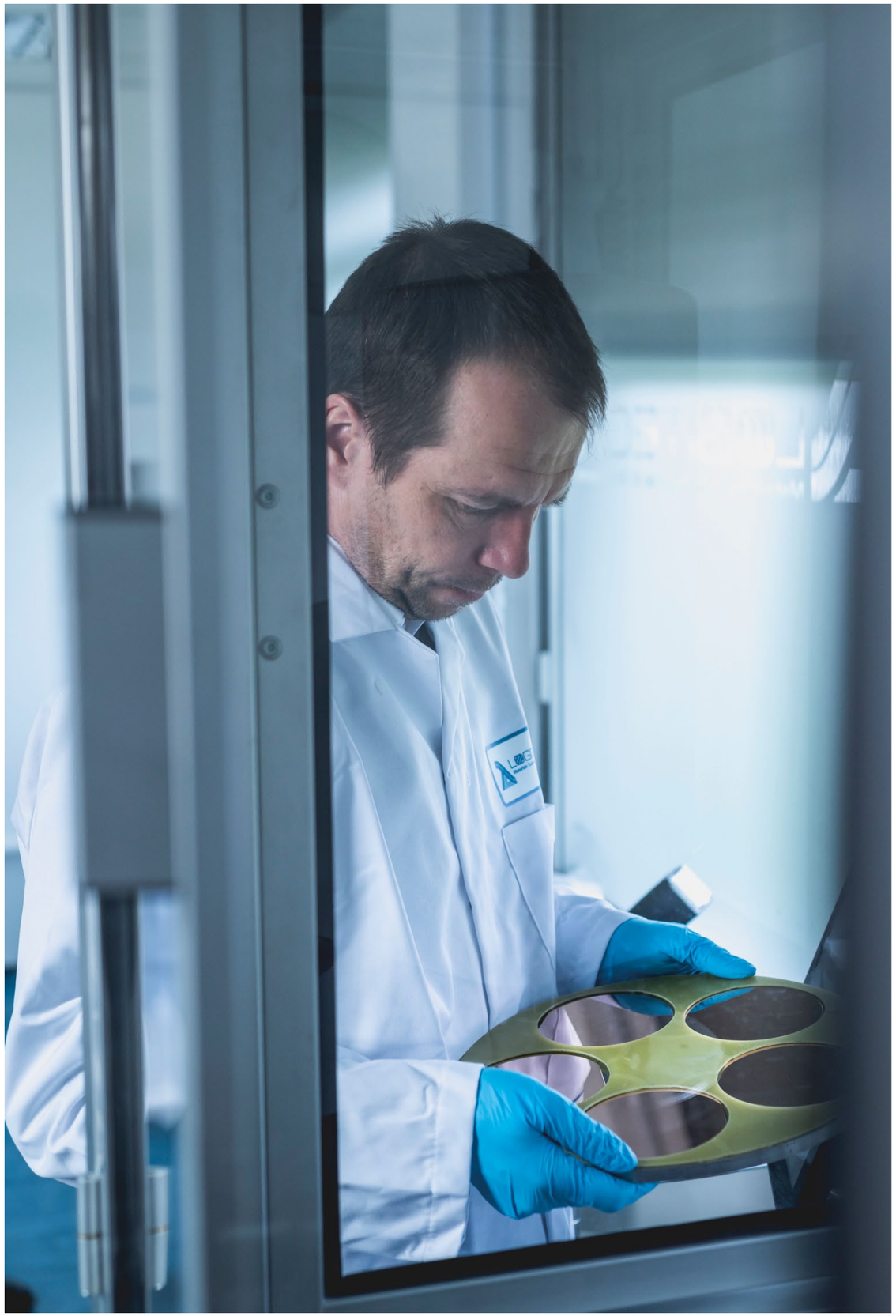
LOGITECH
Materials Technologists & Engineers



# KNOWLEDGE & PROBLEM SOLVING

Logitech is a world leader in materials processing, shaping and surface finishing technologies. From a business developing out of a project in 1965, to research advanced semiconductors at the University of Glasgow, one of the world's oldest and widely-respected academic institutions, Logitech has grown a wealth of knowledge and problem-solving skills in wafer surfacing, thinning and the chemical mechanical polishing of semiconductor wafers.

We specialise in the design and manufacture of lapping and polishing equipment. Also in cutting, bonding, testing and measurement equipment, offering turnkey system solutions for a quick and effective route to complete success in any device-fabrication process.

Our technical team work in confidence with customers, identifying the most relevant system for optimum results on their particular wafer-processing issues. Initial discussions provide a detailed understanding of production quantity, wafer thickness, surface finish and geometric tolerance requirements.

Typical options in this area:

- Wafer support-disc bonding of low, medium or high precision
- Jig-controlled mechanical lapping and polishing using single, or multi-workstation machines
- Mild chemo-mechanical, or aggressive chemical, etch polishing within a controlled environment
- CMP processing using a dedicated system
- Gauging and inspection facilities to suit the required end result

Logitech offers a breadth of knowledge and problem solving skills in semiconductor wafer surfacing, thinning (back-lapping) and geometric control across a wide variety of semiconductor materials used for various applications.

These materials include:

- Silicon
- Silicon carbide
- Sapphire
- Gallium arsenide
- Indium phosphide

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# PROCESSING FRAGILE MATERIALS

**Some materials used in semiconductor applications can be considered soft and / or fragile to process in comparison with other materials. These tend to be ranked lower on the Mohs hardness scale.**

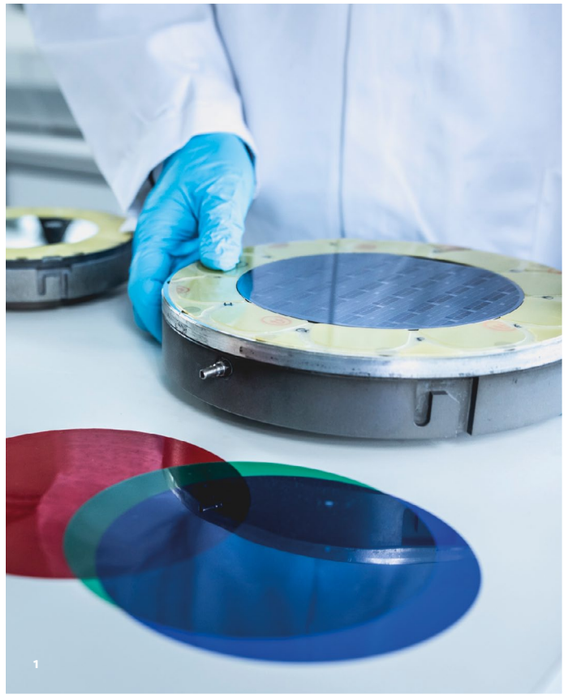
**As those within the industry are well aware, semiconductor materials can be expensive, so for more fragile materials, specific processes must be determined to reduce the risk of damage or breakage.**

All semiconductor wafers go through several customised stages during manufacture. These include: slicing the wafer from the crystal; preparing the surface prior to fabrication; subsequent thinning of the device through the deployment of lapping and polishing techniques. As these materials tend to be fragile, greater consideration must go in to the manufacturing process to achieve optimum productivity and quality.

With over 50 years of experience in processing these fragile semiconductor wafers, Logitech have developed specific processes for the most popular materials used in the industry today.

1: Logitech precision systems can process wafers in a variety of sizes by utilising custom-made templates and carriers

2: Control process parameters and monitor real time data collection via the Graphical User Interface (GUI) on Logitech precision systems



## Silicon (Si) / Mohs: 7

Silicon (Si) is one of the most common elements on the planet and a popular material for electronic wafer device production within the industry. Despite ranking 7 on the Mohs hardness scale, silicon can be extremely fragile to process in thin wafers. Many research and production facilities are increasingly seeking successful methods for thinning down the top wafer of a two-wafer fusing bonded assembly to achieve a final thickness as low as <10 µm. A typical application for such a process would see ultra-thin wafers used as 'flexing' mirrors to redirect laser light for HD screens.

### Processing

In a typical silicon lapping and polishing process, a series of steps are used with a different slurry solution. Lapping processes are undertaken using an abrasive slurry with tightly controlled particle size distribution with high purity. The slurry is chosen to provide optimum balance between material removal speed and maintaining the integrity of the underlying silicon wafer. A first coarse lapping process in undertaken to remove material within 50 µm of the end point target specification. A second medium / fine lapping process is used to remove materials to within 10 µm.

The final stage involves removing final micrometers of material and any damage cause during lapping. After all three stages a typical roughness of Ra <1 nm is achievable. All three processes can be undertaken on a precision system designed for both lapping and polishing such as the Logitech PM6, LP70 or Akribis-air systems.

## Indium phosphide (InP) / Mohs: 4

Indium phosphide (InP) is a compound semiconductor composed on indium (In) and phosphorus (P), belonging to a group of materials commonly known as III-V semiconductors. InP is used in high-power and high-frequency electronics, and boasts a superior electron velocity in comparison to more common semiconductor materials. Its direct band gap also makes it useful in the production of opto-electronic devices such as laser diodes.

### Processing

InP has a face-centred cubic crystal structure almost identical to that of gallium arsenide and most III-V semiconductors. InP wafers must be prepared prior to device fabrication, and all III-V wafers must be lapped to remove any surface damage which occurs during the slicing process. Wafers are then chemically mechanically polished / planarized (CMP) for the final material removal stage, to attain a super-flat mirror-like surface with a remaining roughness on an atomic scale. The wafer is then ready for device fabrication.

## Gallium arsenide (GaAs) / Mohs: 3·5

Gallium arsenide (GaAs) is also a compound semiconductor; a mixture between two elements gallium (Ga) and arsenic (As).

GaAs wafers have a variety of uses, and are components in some diodes, field-effect transistors (FETS) and integrated circuits (IC). GaAs components are useful at ultra-high radio frequencies and in fast electronic switching applications, which benefit from GaAs generating less 'noise' than many other types of semiconductor components. As a result, they are useful in weak-signal amplification applications.

### Processing

In the processing of GaAs, 4"/ 100 mm wafers are the most common size processed by our customers. Logitech systems provide a complete solution in the production of lapped and chemo-mechanically polished GaAs wafers, delivering repeatable surface finishes to the highest quality.

### Results

| Process metric | Process step | Si (4") | InP (4") | GaAs (3") |
|---|---|---|---|---|
| Final thickness | After polish | Typically 50 µm or thinner | Typically 50 µm or thinner | Typically 50 µm or thinner |
| Flatness (TTV) | After polish | < 2 µm | < 2 µm | < 2 µm |
| Surface finish | After lap | < 200 µm | < 200 µm | < 200 µm |
| | After polish | 1–2 nm | 1–2 nm | 1–2 nm |
| Parallelism | After polish | ± 2 µm | ± 2 µm | ± 2 µm |
| Material removal rate (MMR) | Lap | 6–8 µm | 4–6 µm | 4–6 µm |
| | Polish | 0·1–0·2 µm/min | 0·4–0·6 µm/min | 2–4 µm/min |

# PROCESSING HARDER MATERIALS

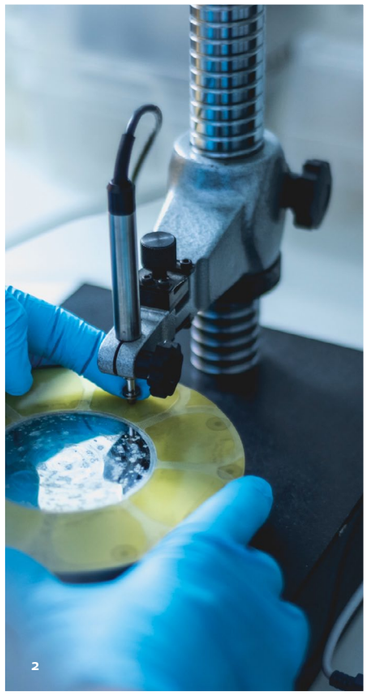
**The search for cost-effective solutions in semiconductor device production, consistently driven by volume and yield, pushes more and more popular materials on to the market, like silicon carbide for example, which are capable of providing competitive cost reductions when compared to the traditional semiconductor technology.**

**With ever increasing industry requirements, however, and the pressure for high productivity, there is no room for error in device fabrication processes.**

These 'hard' materials, which rank highly on the Mohs hardness scale, are notoriously difficult to process, and require a process optimisation to ensure there is no damage or breakage to these expensive wafers, while also maintaining high productivity to ensure the resulting applications' required throughput levels.

The intelligent features and functionality of Logitech's highly automated systems allow for increased material removal rates (MRR), minimised total thickness variation (TTV), minimised subsurface damage, roughness and flatness.


1



2

1: Our in-house process development team are working continuously to develop processes for emerging materials on the market - offering a solution for a variety of materials used in wafer fabrication

2: Logitech offers a wide range of test and measurement products for process step and sample data collection.

## Silicon carbide (SiC) / Mohs: 9

Silicon carbide (SiC) is a chemical compound of both carbon (C) and silicon (Si). SiC's characteristics include high thermal conductivity, high resistance towards oxidation, chemical inertness and a high mechanical strength. This makes it an ideal material for use in a range of applications including biomedical materials, high temperature semiconductor devices, synchrotron optical elements and lightweight, high-strength structures.

SiC possesses superior physics / electronic properties compared to both silicon and GaAs for certain short wavelength optoelectronic, high temperature, radiation resistant and high-power applications.

### Processing

To achieve the precision and surface finish required in hard wafer applications is a skilled job. This is due to the high levels of manual set-up, and the control needed throughout the process. This is not conducive to high levels of throughput demand. Using Logitech's automated systems, we set out to prove that users can ensure accuracy, repeatability and control to confidently deliver optimum surface finish and precise geometric tolerances.

## Sapphire ($Al_2O_3$) / Mohs: 9

Sapphire is typically the gemstone variety of the mineral corundum or aluminium oxide. Due to its remarkable hardness, it can be rated around 9 on the Mohs hardness scale. Sapphire wafers are particularly attractive to the laser industry due to its uniform dielectric constant and high quality crystalline structure, which has led to the increased use of sapphire substrates for blue-laser diodes. The sapphire has also become the basis of today's RF switch applications.

### Processing

The objective of sapphire wafer polishing is to reduce the final thickness of the substrate to the required target value, with a TTV of a better than +/- 2µm and an improved surface roughness of less than 2 nm. This full process can be achieved using a Logitech wafer substrate bonding unit (WSBU) for bonding and using one of our precision lapping and polishing systems, such as the PM6.

By using a Logitech polishing system, it is possible to achieve an ideal surface roughness in advance of further processing using traditional techniques. Each polished wafer will exhibit uniform material removal during the process and result in a consistently flat surface finish.

## Gallium Nitride (GaN) / Mohs: 6–7

Gallium nitride (GaN) is a material increasing in popularity within the semiconductor industry due to its competitive costs reduction when compared to traditional semiconductor technology. GaN is currently used in high-power transistors capable of operating at high temperatures. These transistors take advantage of GaN's ability to produce a high-power output from a small physical volume. This makes GaN an ideal material for future development in a wide range of applications within the opto-electronic field.

### Processing

Prior to processing GaN, the wafer must be bonded to a rigid glass substrate. For best results, this can be achieved on a Logitech wafer substrate bonding unit, designed for semiconductor wafer bonding of expensive materials which minimises any breakage while retaining the highest quality sample yield.

Once the sample is bonded, it can be safely mounted on to a Logitech precision air jig for processing using the Akribis-air: intelligent sample preparation system.

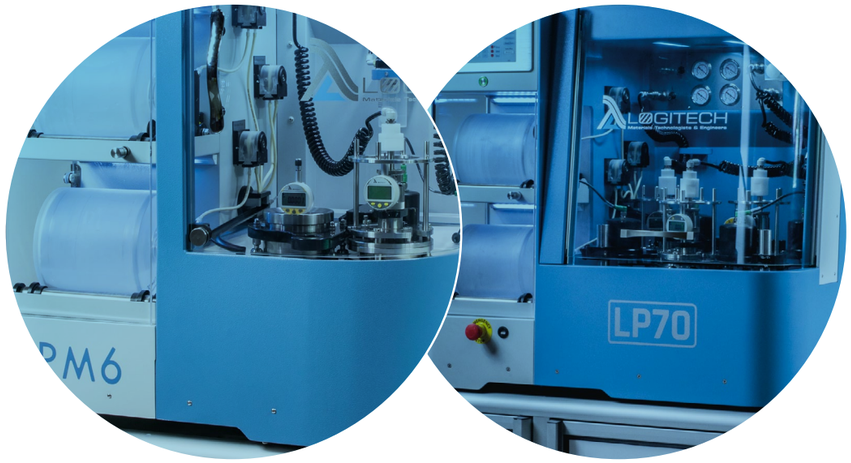
### Results

| Process metric | Process step | SiC (4") | $Al_2O_3$ (2") | GaN (4") |
|---|---|---|---|---|
| Final thickness | After polish | Typically 100 µm or thinner | Typically 100 µm or thinner | Typically 100 µm or thinner |
| Flatness (TTV) | After polish | < 2 µm | < 2 µm | < 2 µm |
| Surface finish | After lap | < 150 µm | < 300 µm | < 150 µm |
| | After polish | < 1 nm | 1–2 nm | 1–2 nm |
| Parallelism | After polish | ± 2 µm | ± 2 µm | ± 2 µm |
| Material removal rate (MMR) | Lap | 1–3 µm | 3–4 µm | 1–2 µm |
| | Polish | 0·2–0·5 µm/min | 0·2–0·4 µm/min | 0·1–0·3 µm/min |

# EQUIPMENT GLOSSARY

Whatever your application requirements, Logitech equipment can support your wafer fabrication processes. Our wide range of precision systems provide a full service solution for wafer thinning from bonding, to lapping bulk material removal to chemically polishing for the attainment of defect-free, mirror-like surfaces that are used in device production and test and measurement equipment for process step and sample data collection.

To see our full product range please visit our website: logitech.uk.com




## PM6

The PM6 precision lapping and polishing machine will reproduce processing results typically found on production-scale equipment. Highly flexible in use, the PM6 allows users to work with both hard and fragile semiconductor materials.

### Key features

- Single station machine with a wafer process capacity up to 100 mm / 4"
- Plate speeds up to 100 rpm facilitating faster lapping rates
- Bluetooth enabled features
- Automatic plate flatness control




## LP70

The LP70 multi-station precision lapping and polishing system is a bench-top machine designed to run concurrent automated processes, allowing operators to achieve repeatable results to stringent sample specifications. With four workstations as standard, this system is the optimal solution for both production and research laboratories.

### Key features

- Four station machine with a wafer process capacity of up to four 100 mm / 4" or two 150 mm / 6"
- Plate speeds up to 100 rpm facilitating faster lapping rates
- Bluetooth enabled features
- Automatic plate flatness control


## Akribis-air

This intelligent sample preparation system delivers the ultimate in processing innovations and is a highly automated stand-alone machine. Offering dynamic load control of Logitech's intelligent air jigs, with reliable and highly accurate results across a wide range of applications.

### Key features

- Four station machine with a wafer process capacity of up to four 100 mm / 4" or two 150 mm / 6"
- Plate speeds up to 100 rpm facilitating faster lapping rates
- Bluetooth enabled features
- Automatic wafer thickness control
- Intelligent air-driven jigs
- Dynamic load control


## CP 3000 / CP 4000

The Logitech CP chemical polishing systems have been developed to be resistant to the chemicals used in polishing processes, for example: bromine methanol, hydrogen peroxide, ammonia, standard acid or alkaline, standard acid or alkaline etches

The CP 3000 is a compact system designed to fit inside your exisitng fume extraction cabinet, with a wafer process capacity up to 100 mm / 4".

The CP4000 integrated fume hood allows for connection to a standard laboratory extract system with a wafer process capacity of up to 200 mm / 8", or multiple smaller wafers.

Logitech's precision lapping and polishing systems are available for a variety of wafer sizes and throughput requirements — including single station units and multiple station units for multi-wafer processing.

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## CMP Orbis

The Logitech CMP Orbis is a precision engineered, floor standing CMP tool ideally suited for R&D environments. Typically used in applications which conduct pilot production tests with optimum analytical capabilities and enhanced processing performance.

### Key features

- High capacity workspace for samples up to two 200 mm / 8"
- Laboratory scale footprint
- Ideal for use in R&D environments and pilot process testing
- Downloadable data for analysis of process parameters

## CMP Tribo

The Logitech CMP Tribo is a bench-top chemical mechanical polishing system ideal for tribological or CMP applications. This system can achieve nanometer level material removal on a wide variety of wafers / substrate materials used in today's device fabrication processes.

### Key features

- Wafer process capacity of up to 100 mm / 4"
- Ra to subnanometer levels on substrates
- Ideal for tribological and chemical mechanical polishing applications
- Customisable carrier heads / templates: polish standard wafer diameters, unique diameters or shapes as well as small wafer dies

## DL driven-head system

The DL high-speed lapping systems process materials with high geometric precision. The capacity range of the DL systems make these ideal for small research laboratories through to production environments.

The DL also has the ability to process multiple smaller samples with the use of customised Logitech templates and chuck-faces.

### Key features

- Process up to 200 mm / 8" samples
- Single or four station unit
- Ideal for the lapping of hard and soft materials

## DP driven-head system

The DP high speed polishing systems have been designed for semi-automated final stage polishing of hard materials. The systems are capable of applying up to 200 kg download on the DP1 and 50 kg download per carrier head on the DP4, resulting in the highest sample throughput of any Logitech polishing system.

### Key features

- Process up to four 200 mm / 8" wafers or 48 50 mm / 2" wafers simultaneously
- Single or four station unit
- Designed for chemo-mechanical based polishing processes
- Ideal for polishing silicon carbide, gallium nitride and sapphire

## Wafer substrate bonding unit

The Logitech wafer substrate bonding units (WSBU) are premium bonders for the processing of a wide range of materials including fragile semiconductor wafers such as silicon and gallium arsenide. The bonding units are utilised vacuum bonding and diaphragm pressure to minimise breakages with these expensive materials whilst retaining the highest quality of sample yield.

### Key features

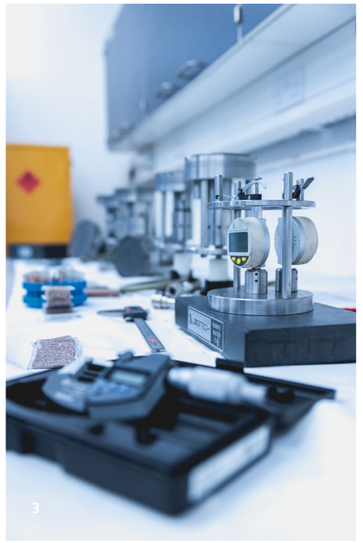
- Available as single station or triple station bonding units
- 100 mm / 4", 150 mm / 6" or 200 mm / 12" wafer capacity
- Save and re-call recipes via the graphical user interface for easy process repeatability
- Excellent wafer support disc parallelism

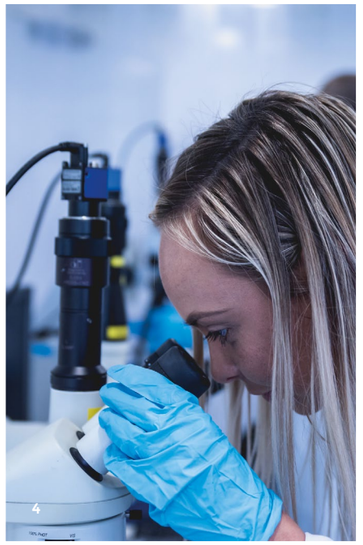
# TECHNOLOGY TRANSFER

1: Logitech training programmes are carried out at our purpose built, in-house laboratories

2: Customers can expect hands-on, one-to-one training with a Logitech Process Engineer


3 & 4: Our in-house facilities include a CMP Lab, a Test & Measurement Lab, a Geology Lab and our Main Training Lab which is fully equipped for customer training sessions





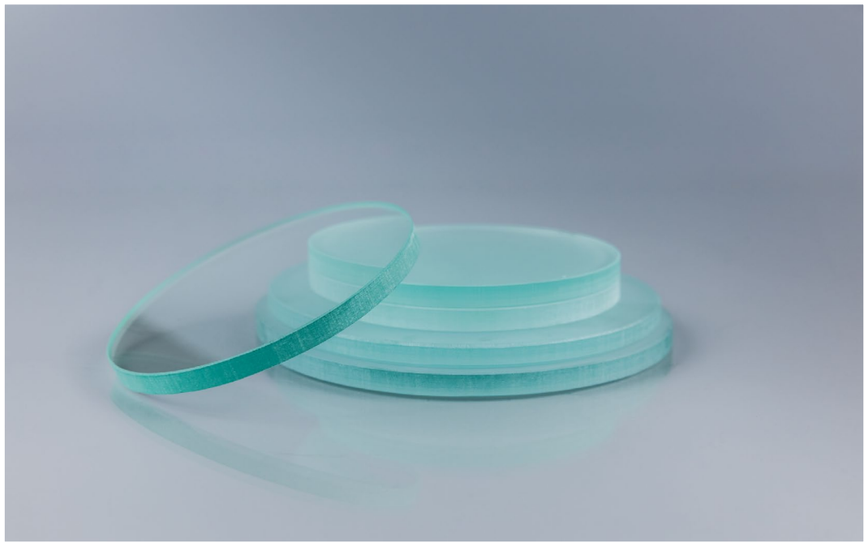
Logitech's Technology Transfer programme is an integral part of our materials processing systems. Our training courses offer over 50 years of processing expertise and have proven to be the best method of providing information and guidance on the use and maintenance of our systems.

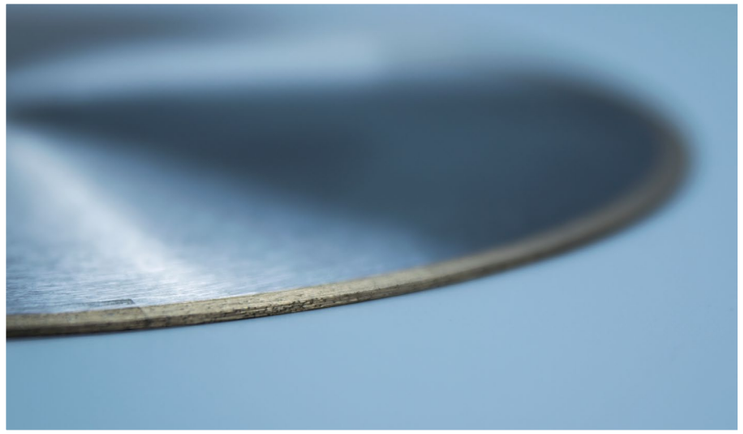
Our training courses are held at our purpose built laboratories at Logitech in Scotland. With over 50 years of combined experience, training will be given by our process development engineers, demonstrating the most up-to-date and advanced process techniques available. Trainees benefit from our continuous research and development, which means that process methods are improved and updated constantly.

Emphasis is placed on trainees producing their own work, allowing them to create the highest standard of specimen possible, adhering to strict application specifications, using process methods introduced and coached by our engineers. Each course is limited to just two or three individuals, usually with similar training needs, allowing for close, often individual, tuition.

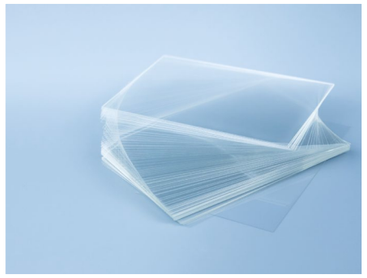
As the course is tailored to your exact requirements, all of your specific needs and problems receive full attention. Our dedicated process team are always on hand, on-site, or reachable by email, to offer further advice and problem solving knowledge.

5 & 6: Our in-house Process Development Training Engineers have combined over 50 years of experience



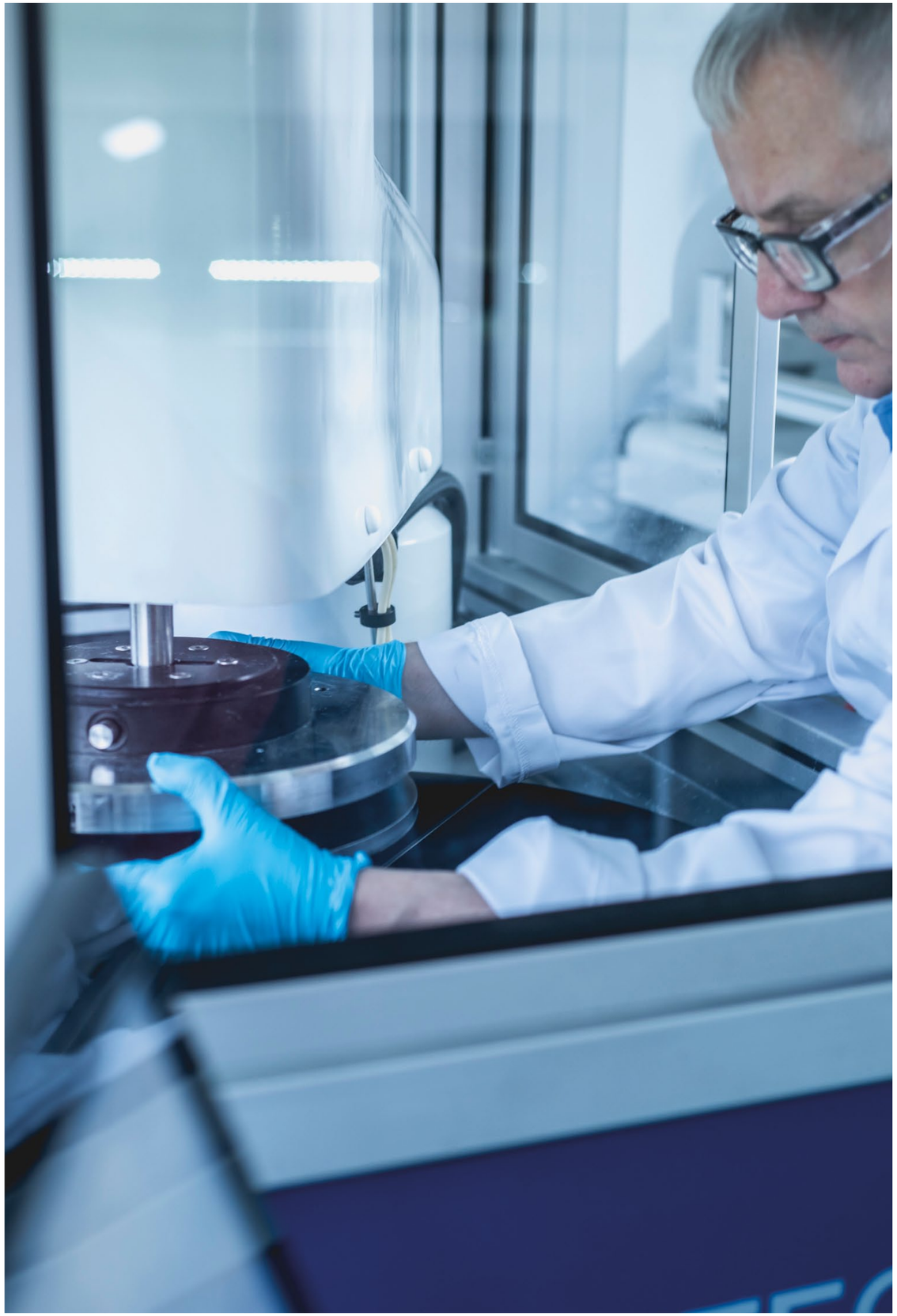




Logitech offers an extensive range of certified consumable products, carefully developed to work in unison with our range of sample processing systems and machinery. Our own research and analysis provides us with the expertise to achieve the best results from Logitech equipment using diverse material processing applications. Utilising Logitech's consumable range with your Logitech system will enable you to achieve optimal performance and maximise the lifespan of your Logitech equipment.

Visit our online store:
**store.logitech.uk.com**

# CONSUMABLES



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