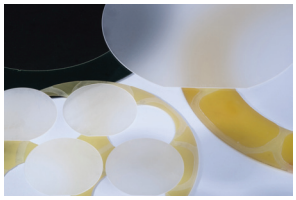
Application Note
LED Substrate Preparation
Silicon Carbide, Sapphire & Gallium Nitride



1. Introduction

Due to the continuing growth of the LED market and demand for larger wafers, Logitech has seen a substantial increase in the sale of system solutions for the preparation of Sapphire, Silicon Carbide (SiC) and Gallium Nitride (GaN) substrates.

LEDs are typically manufactured on Sapphire substrates, around 90% of the blue LEDs currently in production, the remaining 10% are made from SiC substrates. It is estimated that there will be a 20% year on year demand for Sapphire substrates for LED fabs.

However due to the high lattice mismatch between Sapphire substrates and GaN LED materials, blue LEDs are limited in efficiency. This has driven the interest of other contenders such as SiC and Zinc Oxide (ZnO).

SiC characteristics include low lattice mismatch, high thermal conductivity, high resistance towards oxidation, chemical inertness and a high mechanical strength. Making it an ideal material for use in LEDs and other applications such as, biomedical materials, high temperature semiconductor devices and lightweight, high strength structures.

The ability of GaN to produce a high output of power from a small physical volume. This coupled with the material's high efficiency in power amplifiers at ultra-high and microwave frequencies make GaN an ideal material for future development in a wide range of opto-electronic applications. GaN wafers are not currently used for LEDs due to their high cost.

2. Application requirements

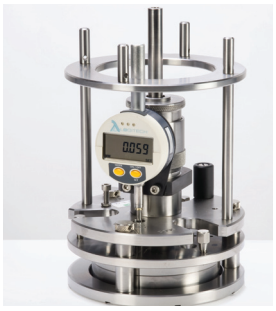
In each case the objective of Sapphire, SiC and GaN wafer polishing is to reduce the final thickness of the substrate to the required target value, with a TTV of better than +/-2 microns and an improved surface roughness of less than 2nm. This is achieved by firstly bonding the wafer(s) to a rigid glass substrate, using the Logitech Wafer Substrate Bonding Unit (WSBU).

Once bonded, the wafer(s) require to be lapped in order to remove the excess material prior to being polished. The lapping process is carried out using a Logitech High Speed Lapping & Polishing System or a DL machine with a Logitech PP6, PP8 or PP9 Precision Jig.

Logitech High Speed Lapping & Polishing System

For lapping to take place the jigs are loaded onto a cast iron lapping plate and a variety of automated or manual display options are available to allow material removal to be monitored.

After lapping, the wafers are manually cleaned and removed from their glass support disks. The wafers are then transferred to a wafer template holder for the High Speed Lapping and Polishing, DP1 or DP4 Driven Head Precision Polishing Systems. Each of these systems deliver highly accurate, polished wafers in a wide variety of quantities to repeatable levels of optical grade polish.



Logitech PP6 Polishing Jig

3. System Specification

Logitech offer a number of different systems for polishing Sapphire, SiC and GaN dependent upon the number of wafers being processed. Each system will, however, consist of the following:

Bonding Unit	WSB2	Single Station	research level
	WSBU	Three Station	production level
	WSB300	Single Station	production level
Lapping System	High Speed	Single Station	research/small batch
	DL1	Single Station	research/small batch
	DL4	Four Station	full production level
Holding Fixtures	PP6	Max 4" substrate	High Speed, DL
	PP8	Max 6" substrate	PM5, LP50, DL
	PP9	Max 8" substrate	DL
Polishing Systems	High Speed	Single Station	research/small batch
	DP1	Single Station	research/small batch
	DP4	Four Station	full production level

4. Processing

A. Mounting, retention & lapping

The Sapphire, SiC or GaN wafers are temporary wax bonded, fabricated face down, onto glass support discs using the Wafer Substrate Bonding Unit.

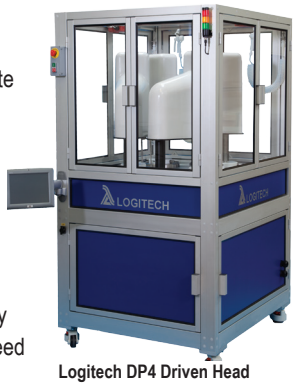
This system produces consistently high standards of wafer to support disc parallelism, irrespective of whether one large wafer or a number of smaller wafers of differing thicknesses are being bonded. Once successfully bonded, the support discs can be mounted onto the vacuum chuckface of a Logitech

lapping jig. The jig is then inverted and placed face downwards onto a cast iron lapping plate which is then set to rotate at speeds of up to 300rpm whilst Logitech abrasive slurry is fed across the plate surface at a constant flowrate.

B. Mounting, Retention & Polishing

After removing excess material from the substrates, by lapping, it is necessary to polish the wafer surface using either one of the High Speed Systems or a DP System. This process produce a high quality optical grade surface on each of the wafers.

The systems uses a detachable carrier system for holding and retaining each individual wafer, without the need for using a glass support disc. For this reason, the wafers are dismounted from the disc prior to being set into their individual holders on the carrier template. Each template is made to suit individual customer requirements, thereby ensuring optimal results from the polishing process.



Logitech DP4 Driven Head Polishing System

Whether the High Speed, single station DP1 or four station DP4 is being used, the SiC or Sapphire wafers will be polished within a very quick time frame. This is due to the high speed rotation of the polishing plate, combined with the independent rotation of the carrier head.

With a constant supply of polishing slurry being fed across the plate it is possible for the systems to reduce polishing times of these traditionally difficult to process materials. This can be over 50% faster when compared to non-high speed systems.

The high rotational speed used by the systems creates frictional forces on the process plate which in turn creates an elevated process plate temperature. This heat is highly beneficial to the material removal rate and is essential to the successfull polishing of each of these materials.

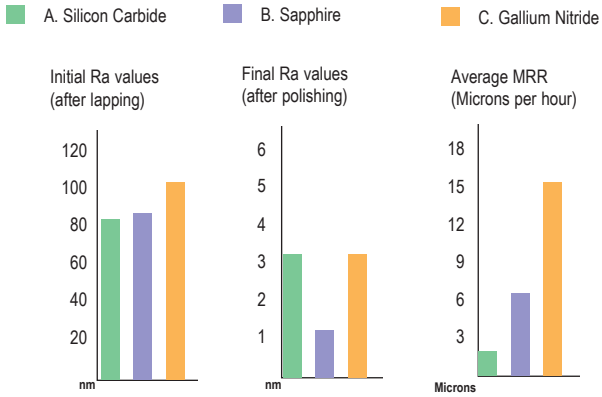
Throughout the polishing process, the systems offers a high level of controllability, as manual manipulation of the process can be carried out “in situ”. The operation control panel allows process parameters such as plate speed, downward load on the carrier(s) and slurry flow rate to be instantly and accurately altered.

5. Results

By using a Logitech polishing system to complete the preparation of SiC, Sapphire or GaN substrates, it is possible to achieve ideal surface roughness in advance of further processing using traditional CMOS techniques. Each polished wafer will have had a uniform amount of material removed during the process and a consistently flat surface produced.

By varying the pressure (load) applied to the substrates during processing it is possible to achieve an Lapping removal rate of of 18µm per minute with Sapphire and 13.8µm per minute with Silicon Carbide (SiC).

The following Silicon Carbide and Gallium Nitride results are taken from a batch of 12 x 2” diameter wafers processed on the DP1 research unit, whilst the Sapphire results are taken from a batch of 84 x 2” diameter wafers processed on the DP4 production level unit.



A. Silicon Carbide (SiC) wafers

Diameter:	2”
Material Removal Rate (MRR):	1-2 microns per hour
Final Ra value:	<3nm
Flatness:	+/- 2 microns
Bow:	<25 microns

B. Sapphire wafers

Diameter:	2”
Material Removal Rate (MRR):	6 microns per hour
Final Ra value:	<1nm
Flatness:	+/- 2 microns
Bow:	<25 microns

C. Gallium Nitride (GaN) wafers

Diameter:	2”
Material Removal Rate (MRR):	15 microns per hour (face dependent)
Final Ra value:	<3nm
Flatness:	+/- 2 microns
Bow:	<25 microns

Using a Dektak 150 surface profilometer.

Logitech Limited
Erskine Ferry Road, Old Kilpatrck, Glasgow G60 5EU, Scotland, U.K.

Tel: +44 (0) 1389 875444
Fax: +44 (0) 1389 890956

e-mail: info@logitech.uk.com
www.logitech.uk.com

LOGITECH
Materials Technologists & Engineers