

C-Plane Sapphire Lapping with Composite Copper Plate

Sapphire is a single crystal hard material. It has several variants based on its crystal orientation. A-Plane, C-Plane, R-Plane and M-Plane are the common sapphire crystal orientations. C-Plane sapphire is the most expensive and it is also durable compared to the rest. The C-Plane has better heat and pressure resistance which makes it ideal for several demanding applications in high-precision optical components. It is highly abrasive and has a higher resistance than silicon, this property makes it a good choice for SOI devices. It is also highly scratch-resistant and resists strong thermal shocks. This material is known to be a challenging material to process or machine due to its hardness and crystalline orientation. Several works of literature stated that the difficulty in surface processing arises either as the material removal rate is very low, or in some instances, the processed surface is with multiple types of artifacts.

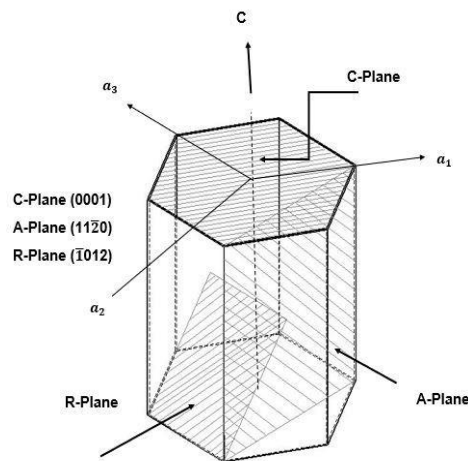


Figure 1. Sapphire Orientation (2)

Motivation and Detail for Case Study

This case study intended to show the effectiveness of a combination of diamond slurry with a composite copper plate in improving the material removal rate of C-Plane sapphire. The results found from past studies show that a far better material removal rate can be achieved using a composite copper plate without affecting the surface significantly (1,2,3,4).

The test was conducted on a raw cut C-Plane (0001) sapphire. The sapphire sample thickness was 2 mm with a diameter of 25.4 mm. Qual Diamond polycrystalline size 2-4 μm slurry was used as a lapping slurry and lapped for 60 minutes on either a composite copper plate or with Qual Diamond QDPD polishing pad. The surface was then inspected visually and using a 3D optical profiler. Material removal rate (MRR) was calculated based on weight differences. See Table 1 for results comparisons.

Results and Conclusion

The sapphire wafer after lapping with copper plate has no scratches and has a higher MRR. The magnitude is three times more than the one polished using the pad. The surface also has no scratches and artifacts. This demonstrates that the combination of slurry and the copper plate is an ideal lapping solution for achieving higher MRR and better surface quality on C-Plane sapphire wafers.

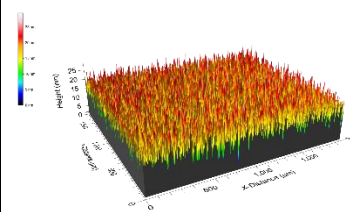
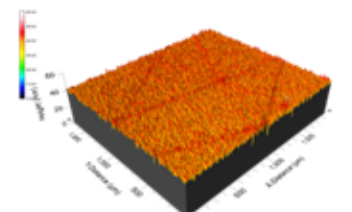
Slurry Type	QD POLY	QD POLY
Plate/Pad	Copper Plate	QDPD
Duration	60 minutes	60 minutes
MRR ($\mu\text{m/hr}$)	~35	~10
Ra (nm)	2.2	1.8
Scratch	No visible scratches	Visible scratches
White-Light Interferometry		

Table 1. Sapphire lapping with composite copper plate and polishing pad results comparisons.

References:

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