Technical-Report

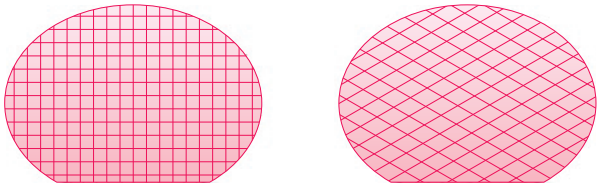
Plasma Dicing and Scribing Technology for GaAs Based Devices

GaAs (Gallium Arsenide) is used in various devices, including devices for communication and optoelectronics. During fabrication, dicing techniques (e.g. by dicing blade, laser dicing, and diamond scribing) are widely used. However, these techniques create three problems: 1) physical or heat damage to the devices, 2) loss of usable wafer area because of the dicing width, and 3) dependence of dicing direction on crystal orientation (it becomes difficult to cut chips into ideal shapes). SAMCO has already reported GaAs plasma dicing technology, which solves all these problems. This article introduces results from our latest experiment on GaAs plasma dicing.

The key requirements of GaAs plasma dicing are high speed, high anisotropy, and high selectivity to the photoresist mask. These requirements can be achieved using SAMCO's high-density plasma etching system (RIE-200iP) equipped with our patented Tornado ICP coil.

■ Plasma Dicing

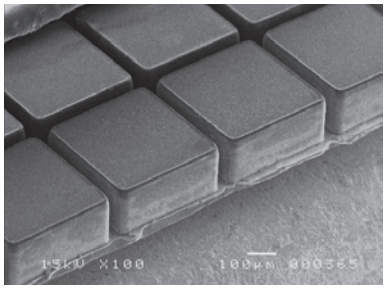
The crystal orientation determines the ease or difficulty in dicing GaAs substrates.



Easy orientation　　Difficult orientation

Figure 1: GaAs crystal orientation types

First, SAMCO performed a plasma dicing demonstration on a wafer with a difficult crystal orientation.

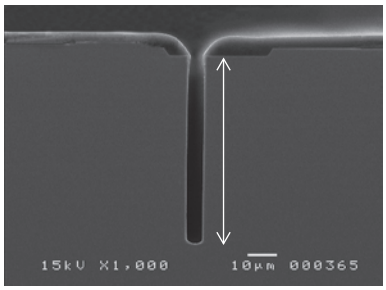


Rate = 3.3 µm/min
Selectivity = 30.7
Etch depth = 148 µm

Figure 2: GaAs plasma dicing results

Figure 2 shows the result of GaAs plasma dicing of an LED pattern with approx. 40µm openings to a depth of 180µm. The GaAs wafer also included AlGaAs grown on it; the combined etch rates were 3.3µm/min, with a GaAs/PR selectivity of 30.7. To allow for SEM observation, the process was stopped prior to through-etching at a depth of 148µm. The crystal orientation did not affect the etching profile, and dicing with smooth sidewalls was achieved. Additionally, chipping on each device did not occur, as no blade was used. Furthermore, this plasma technology prevented damage to the sidewalls of LED devices.

■ Plasma Scribing

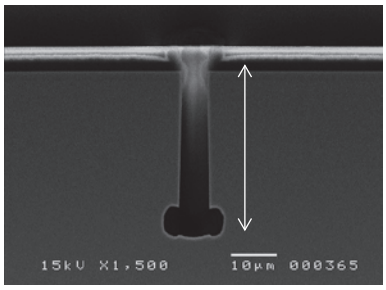


Rate = 1.78 µm/min
Selectivity = 22.3
Etch depth = 60.7 µm

Figure 3: GaAs plasma scribing results

Secondly, we achieved plasma scribing with narrow width. As seen in Figure 3, an anisotropic profile with a 60 µm depth and 5 µm width (adequate for scribing) was achieved. GaAs etch rate was 1.78 µm/min, and GaAs/PR selectivity was 22.3. The process was performed on a 6" wafer, and uniform scribing across the entire wafer was observed. We achieved stable GaAs plasma scribing with no damage to the devices.

■ Unique Plasma Scribing



Rate = 2.0 µm/min
Selectivity = 28
Etch depth = 36.0 µm
(Approximately)

Figure 4: Example of unique plasma

Finally, we would like to introduce a special process. Figure 4 portrays a vertical profile with a side etching process occurring towards the end of the scribing process. This side etching process creates a unique profile that first maintains an opening width and then expands outward towards the end. The etch rate was approx. 2 µm/min, and GaAs/PR selectivity was about 28. SAMCO's GaAs plasma dicing technology enables these unique profiles and can improve yield rates of GaAs based devices. This GaAs plasma dicing technology can serve various applications, including via hole processing on RF devices.

Reference:
[Technical Report] Deep Etching of Compound Semiconductors