Laser dicing compound wafers

As wafer materials evolve, water-jet guiding laser technology is emerging as a natural successor of the abrasive saw.

COMPOUND MATERIALS HAVE indisputable advantages over silicon-based materials. These include higher frequency operation, better signal processing in congested frequency bands and greater power efficiency.

For the years 2002–07, the compound semiconductor IC market is predicted to show average annual growth of 22 per cent. The forecast for the IC market is 10 per cent (source: IC Insights). Today, GaAs is already proving its potential in opto-electronic systems for military, medical and LED lighting applications.

In contrast to common Si wafers, however, chip singulation of GaAs wafers is a real challenge. The main reasons for this are the material's mechanical and chemical properties. What's more, pure compound GaAs contains 51.8 per cent wt arsenic and is, therefore, considered a hazardous material. It has been described as toxic by inhalation and identified as a possible human carcinogen. Obviously these facts raise many environmental, health and safety concerns.

Other factors that make GaAs wafers difficult to dice are their fragility and brittleness. Also, it is important to remember that although GaAs substrate price is not as high as it was, it remains relatively high.

The laser answer

Over the past months, the semiconductor industry has focused a good deal of attention on a water-jet-guided laser called Laser Microjet® (LMJ). A thin water jet acts as a light guide, driving the laser onto the work material by means of reflection. As well as guiding the laser, the water jet cools the work material at exactly the point where it is being cut and removes any molten material. In fact, temperature levels never exceed 160°C during dicing, no matter what the working conditions are.

The low-pressure jet also ensures that the wafer is not damaged either mechanically (chipping) or thermally during dicing. Thus the LMJ is particularly effective on brittle and difficult-to-machine materials such as GaAs, even when the thickness is as low as 25µ. Furthermore, the jet's high laminarity provides a constant kerf width that is equal to its diameter (40, 50 or 75µ depending on the nozzle diameter).

Chip singulation of GaAs wafers is a real challenge

Another interesting advantage that the LMJ has over other processes is that its speed of operation is thickness-dependent. Since GaAs is used in extremely compact structures (thin chips), high cutting speeds are possible.

As regards safety, several tests performed on the LMJ have shown a total absence of arsine gas in the air during GaAs wafer dicing. This is not surprising given that the laser beam is combined with the water jet and used only in short pulses (approximately 450ns). The time for interaction between the laser light and the material is, therefore, very short and is followed immediately by cooling. However, the concentration of arsenic in the wastewater is high, so that water should be filtered or recycled appropriately. In brief, the LMJ does not require any safety systems other than those employed for the abrasive saw.

Succeeding the saw

The LMJ has obvious advantages over the more traditional scribe-and-break and abrasive saw technologies used for dicing GaAs wafers. Although these methods have been improved over the years, they will soon be replaced as wafers become thinner and incorporate more costly and 'difficult' materials. The LMJ is emerging as a viable alternative, rapidly revealing its potential to produce industry-leading results — and not just with GaAs. ■

Company profile

Synova SA, founded in 1996 and based in Switzerland, manufactures cutting-edge laser systems based on the water-jet-guided technique for the semiconductor, electronic, automotive, energy and medical industries. It employs a 40-strong workforce and boasts a modern 3000m² facility that can produce up to 300 machines per year.