Laser-Microjet Ready for Dicing of GaAs Wafers

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Abstract

After successful integration of the Laser-Microjet in machining of thin silicon wafers (dicing and edge grinding), the technology has now entered the field of compound semiconductors with a laser dicing system for GaAs wafers. Following several months of test runs, the laser dicer is now ready for production. RF Micro Devices adopted the Laser-Microjet system because of its speed, cleanliness, absence of chipping or cracking, small kerfs and minimization of environmental issues.

Introduction

For the last eight years, the Laser-Microjet has proved its capabilities in machining a wide range of materials for various industries. Its main market today is semiconductor processing, and the technology has been successfully applied to silicon, low-k wafers, InP, GaAs and SiC (2005).

Because the sample is cooled by the hair-thin, low-pressure water jet that guides the laser beam, the processed material does not sustain thermal damage. Further, a thin film of water on the wafer prevents contamination. The few particles that have not been expelled by the jet cannot attach to the wafer surface. Additionally, the mechanical force caused by the jet is negligible. Processed wafers and dies are thus free of micro cracks, chipping and particles. No structural changes occur in the material, kerf walls are parallel, and dies have high fracture strength.

Dicing of GaAs wafers

Gallium arsenide (GaAs) is a brittle, difficult-to-process material. It tends to chip and break when subjected to mechanical constraints such as those generated by abrasive sawing. To reduce cracks in mechanical methods, speed has to remain low; furthermore, wide streets are needed. The diamond scribe-and-break method has low yield and suffers problems with backside metal layers and crystal orientation; it is not reliable enough, and machine operator intervention is often needed. GaAs is also sensitive to heating, which explains the unsatisfactory results achieved by conventional dry lasers. Additionally, contamination cannot be avoided and toxic gas is emitted while cutting.

Besides avoiding chipping and contamination, the Laser-Microjet is a safe process, as no toxic gas is emitted during Laser-Microjet processing.[1] All toxic materials are captured in the minimized volume of wastewater. Additionally, running costs are low, as there is no tool wear and consumption of DI water is low.[2]

The Laser-Microjet technology is versatile and can be combined with various laser types and wavelengths. For GaAs processing, the most efficient configuration examined to date includes an infrared fiber laser (average power of 40W), and a small 25-micron nozzle. Very thin kerfs of 23 microns can be achieved, and the cutting speed with these settings reaches 40 mm/s for a 125-micron thick wafer.

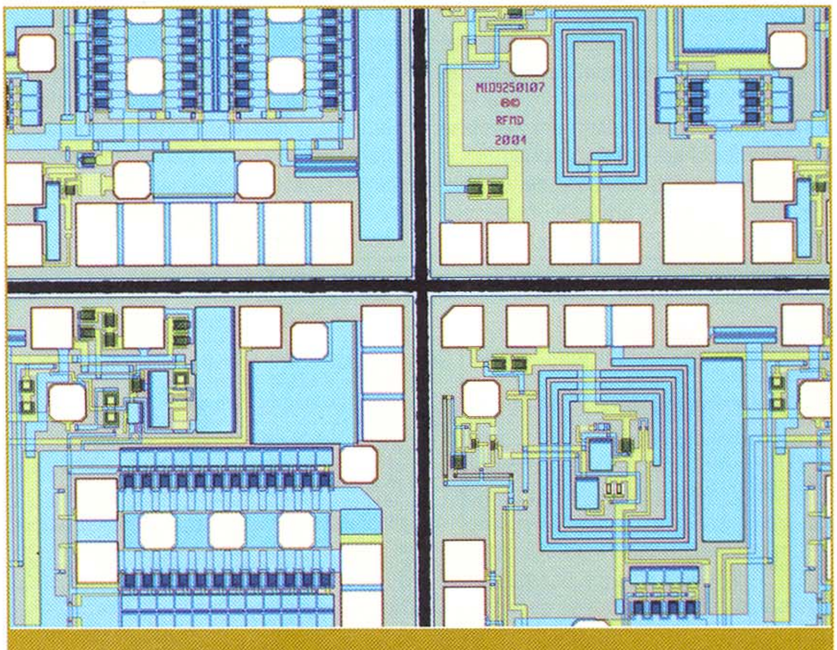

Figure 1. Fast and clean dicing of a thin GaAs wafer using the Laser-Microjet process. (Source: RF Micro Devices)

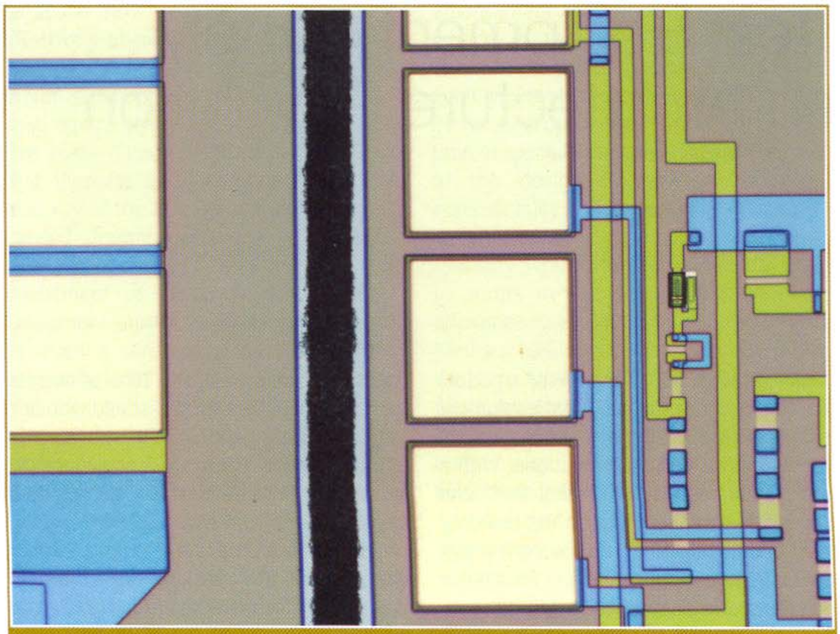

Figure 2. Enlargement of Figure 1 - street width is 35 microns and kerf width is only 23 microns. (Source: RF Micro Devices)

Fiber lasers offer several advantages compared to solid-state lasers, the most important being the excellent beam quality with a maintenance-free source. Furthermore, beam characteristics and pump currents are constant over the entire range of pulse repetition rates, which means that the laser power is independent of the pulse repetition rate. Fiber lasers are more stable, more regular than solid-state laser, and there is no gain depletion. Other advantages include compactness, light weight, low electrical consumption and low need of cooling.

The microjet acts as a liquid fiber extending the fiber laser, elongating the waveguide directly onto the work piece. Smaller water jet diameters can be used, due to the exceptional beam quality of the fiber laser, enabling very accurate cutting. Higher cutting speed can be reached. The cut quality is about the same as with solid-state lasers, but very constant.

The Laser-Microjet technology is already established in the field of silicon processing. It is gaining in popularity due to its ability to surpass traditional diamond wheel dicing and dry lasers in speed and quality on emerging materials.

Figures 1 and 2 are microscope photos of a thin GaAs wafer diced by water-jet-guided fiber laser. The circuits are unaffected by the dicing process and show no contamination; the edges and corners of the dies are free of chipping and cracks. Clean and constant kerfs of 23 microns have been achieved using the fiber laser. On these 100-micron thick wafers, through-cutting is achieved in a single pass at a speed of 50 mm/s.

Because of the quality that the Laser-Microjet is able to achieve, in 2005 RF Micro Devices acquired an LDS 200A for dicing of GaAs ICs. For this leading manufacturer of compound semiconductors, the most significant benefits were the cutting speed, kerf width, cleanness and safety. Recently, the system successfully passed test runs and qualification and is now ready for 24-hour production.

Conclusion

The Laser-Microjet technology is already established in the field of silicon processing. It is gaining in popularity due to its ability to surpass traditional diamond wheel dicing and dry lasers in speed and quality on emerging materials. Especially well suited for thin wafer dicing and edge grinding, the Laser-Microjet has been shown to yield higher die fracture strength and increase the strength of thin wafers after back grinding. Today, the technology has entered the field of compound semiconductors with this first installation of a fully-automatic laser dicing system now qualified for production of GaAs wafers.

References

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