

Innovative Process Solutions

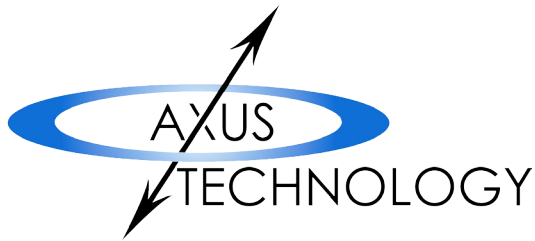
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WAFER EDGE TRIMMING PROCESS

Application Note

May 2013

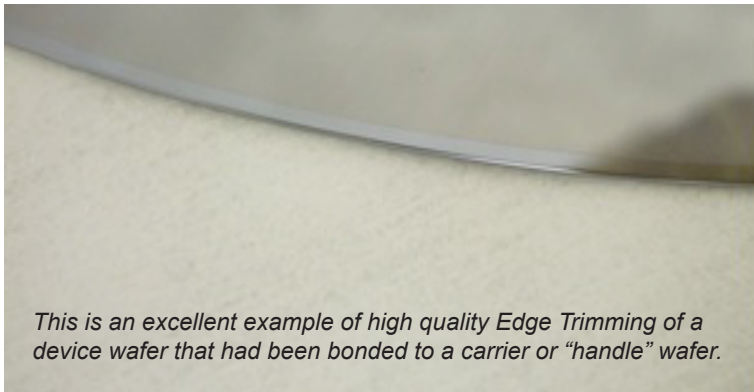


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This paper addresses the topic of Edge Trimming of silicon wafers for semiconductor purposes and describes the processes used at Axus Technology to achieve optimal edge trim results. Edge Trimming is a process step common in the manufacture of semiconductor device wafers that are used in advanced applications such as Through Silicon Via (TSV), Backside Illumination (BSI) and certain applications such as some types of Micro Electro Mechanical Systems (MEMS).

Edge Trimming in Bonded Wafer Applications

The term “Edge Trimming” is now a common industry term used in thin wafer applications such as TSV, and ultra-thin applications such as BSI. Various machine tools and process steps have been tried by equipment and process engineers in an attempt to achieve acceptable if not optimized



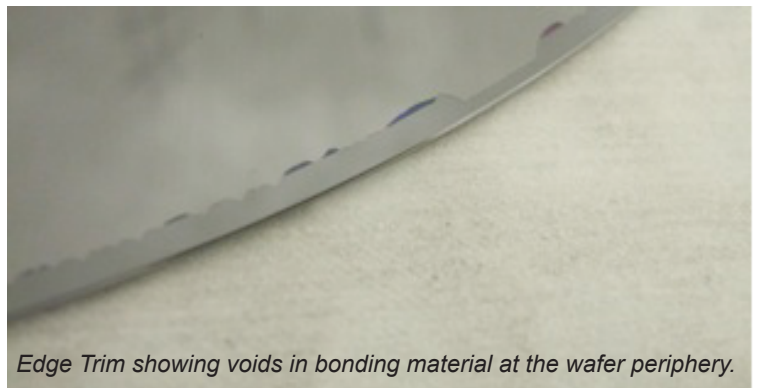
This is an excellent example of high quality Edge Trimming of a device wafer that had been bonded to a carrier or “handle” wafer.

results. In most cases, both TSV and BSI applications require accurate Edge Trimming to achieve the best results. Edge trimming will allow the resultant device wafer to be ground extremely thin, with some applications requiring a thickness of 50 μm (for TSV) or even much thinner (for BSI).

When silicon wafers are ground to these thin dimensions they become very flexible, in

contrast to their more familiar rigid and brittle physical characteristics at thicknesses in the range of 750 μm . In order to successfully handle these

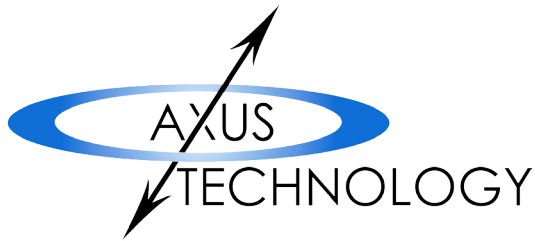
thin wafers during and after the final grinding step, the device wafer is first bonded to a carrier wafer which meets semiconductor industry standards for prime wafers. Before the bonding step, these wafers will pass through at least one CMP processing step, the associated post-CMP, pre-bond cleaning steps, and the bonding process itself. It is critical therefore, that these additional process



Edge Trim showing voids in bonding material at the wafer periphery.

steps also be up to the highest quality industry standards. If not, voids in the bonded surfaces can occur at the edge and throughout the mating surfaces of the device wafer and the carrier wafer.

The edge of the silicon wafer is shaped in an edge grinding step (various shapes are used) to minimize edge chipping and flaking. Later, during the CMP process the edge of wafer is rounded as a result of the polishing process.

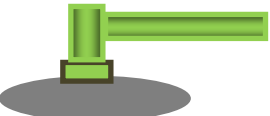
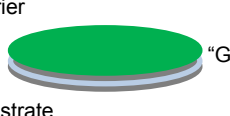
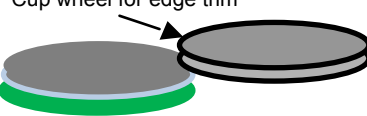
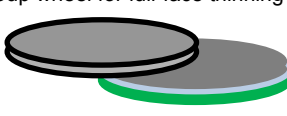
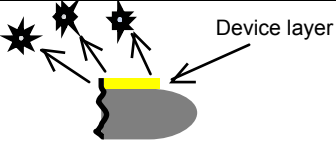
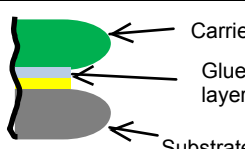
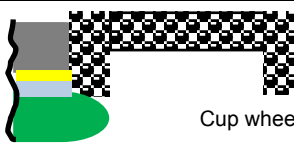
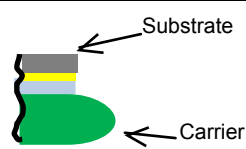


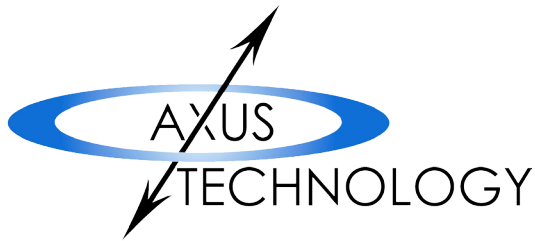
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These characteristics cause incomplete bonding of the two surfaces at the periphery. This incomplete bonding can occur from 2mm to 5mm or more from the edge depending upon the polishing consumables. Edge trimming is used to remove material from the periphery of the device wafer where incomplete bonding has occurred. If the edge trim is not at least past the area of incomplete bonding, then edge flaking will occur and the device wafer will be damaged and not salvageable. If, however, the edge trim is at least past the area of incomplete bonding, then, as the device wafer is ground down to the extremely thin dimensions during the ultra-thinning process, there is enough structural integrity to assure strength and wafer safety.

Axus Technology's Solution

For successful Edge Trimming for the TSV and BSI processes, there are a limited number of acceptable methods that can be used to achieve the desired dimensions with optimized results. Axus Technology process and equipment engineers have developed in-house systems with the associated process steps to achieve excellent Edge Trim results that will meet your specifications and expectations even for flatted wafers. Axus Technology has advanced this technology to the point that the edge trim can be precision-ground down to the carrier wafer surface, into the carrier surface, or stopped on a specific film above the carrier surface.

Pre-Bond Cleaning Mechanical agitation plus DI H ₂ O to loosen and remove all particles	Bonding the Substrate A highly polished, flat, and parallel carrier wafer is bonded to the device side of the substrate.	Edge Trimming Diamond cup style grinding wheel against slowly rotating wafer.	Wafer Thinning This is a highly precise process to mechanically thin the device wafer.
			
			
<p>in preparation for bonding, the cleaning system removes particles that otherwise would remain affixed to the surface of the device side of the wafer.</p> <p>Any particles that are left on the surface will cause incomplete bonding to occur and either certain areas of the device wafer will flake off during grinding or the entire wafer will be destroyed in the grinding step.</p>	<p>The bonding process attaches the carrier wafer to the device side of the substrate to give it the requisite strength and structural integrity to withstand follow-on processes.</p> <p>The bonded pair is turned upside down before entering the edge trimming tool.</p>	<p>The diamond wheel of the face grinding (thinning) tool grinds the edge of the device wafer to make the step-grade periphery profile.</p> <p>With this process it is challenging to stop the edge trimming process before it damages the carrier wafer.</p>	<p>The wafer thinning tool (a precision wafer back grinder) thins the device wafer down to 50 microns (TSV) or less (BSI).</p> <p>This is done so that the device wafer becomes a thin interposer for the TSV applications.</p> <p>In the BSI application, the subsequent ultra-thin die become individual chips which are actual full functioning devices, such as light gathering lenses and their associated circuitry for cell phone cameras which will eliminate the need for auxilliary flash.</p>



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Conclusions

In certain advanced wafer applications such as TSV and BSI, and certain MEMS applications which require thin wafer processing, great benefit can be derived from superior Edge Trimming. This process helps to assure greater structural strength and greater wafer safety during handling and subsequent wafer processing steps.

The edge trimming process requires robust, stable equipment to perform optimized results. Various types of equipment have been shown to be able to successfully achieve the desired results. The primary factor for success however, is the engineering expertise at Axus Technology, including our capabilities and experience working with these specific materials in state-of-the-art applications. We have developed an edge trim process that minimizes wafer handling and provides wafer protection and grinding efficiency to achieve results that meet or exceed current edge trimming performance requirements in the semiconductor and MEMS industries.

How Axus Technology Can Help You

FOR PROCESS SERVICES: Axus Technology's Process Services Department has the required equipment and expertise available to perform Edge Trimming on a contractual basis on your bonded wafer substrates.

FOR EQUIPMENT AND TOOLING: Axus Technology can help with your equipment choice if you are planning to perform this process in-house in your own facilities. Whether you are looking for a standard wafer Backgrinder with the appropriate diamond wheel and control system to perform the Edge Trimming process, or you would like to investigate modified dicing tools to perform Edge Trimming, the Axus Technology team can help you make the best equipment choice for your application.

Please contact us and learn more about this and our many other precision polishing, grinding, and cleaning process capabilities.

About Axus

Axus Technology provides surface processing solutions for a range of semiconductor, MEMS, substrate, and related technologies. Along with providing parts and support services for existing tools, Axus Technology delivers economical leading-edge equipment and process solutions that are precisely configured for end-user applications.

Based in Chandler, Arizona, Axus Technology operations include a fully equipped development and foundry processing facility, as well as design, manufacture, and service operations. For more information visit our website at www.AxusTech.com.