SPTS
An orbotech Company

APPLICATION
BRIEF

Plasma Etch Endpoint Control

Introduction

End-point detection (EPD) is essential for many wafer etch applications to ensure processes are carefully controlled and consistent, to ensure reliable results are achieved wafer-after-wafer, and optimize device yields.

There are many methods used to end-point wafer processes and this application brief aims to describe the techniques available for SPTS's range of etch modules. The techniques either monitor the wafer thickness, analyze changes in the chemical/optical properties of the plasma above the wafer, or monitor the system datalogs.

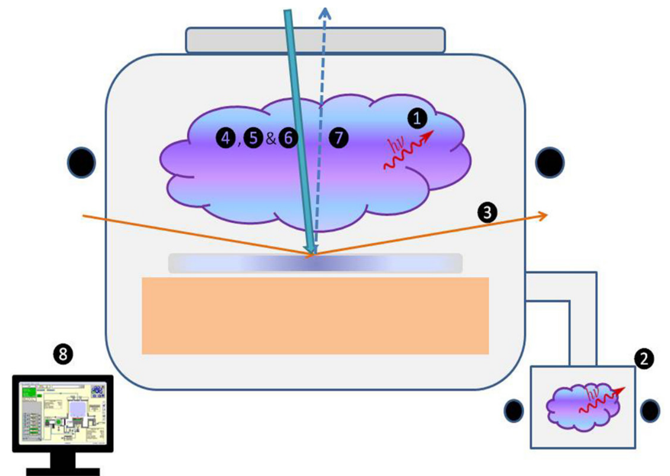

Fig. 1 Illustration showing various SPTS EPD options

	End-point Technique	Applications	Etch Modules				Comments
			ICP	Synapse	DSi & DSi-v	Rapier	
❶	**OES (Ocean, Spectraview, Filter Diode)**	Most etches to a stop layer, multi layer stacks (e.g. VCSELs), inter-wafer cleans for DRIE	✓	✓	✓	✓	
❷	**Claritas™**	DRIE etches to a stop layer or buried cavity.Inter-wafer cleans for DRIE			✓	✓	Requires OES in combination <0.05% open area capability
❸	**ReVia®**	Via Reveal				✓	
❹	**NIR**	Si thinning			✓	✓	For final Si thickness ≤45μm
❺	**White Light Reflectometry**	Tapered Si vias. Multi-layer stacks (e.g. VCSEL)	✓	✓	✓	✓	Common hardware
❻	**White Light Interferometry**	Shallow, blind etches (e.g. Si or glass)	✓	✓			
❼	**Sentinel™**	Plasma dicing after grinding (DAG)				✓	End-point and wafer protection
❽	**Parameter**	Etch where end point is accompanied by a change in datalogged parameters	✓	✓	✓	✓	

❶ Optical Emission Spectroscopy

Optical emission spectroscopy (OES) is a technique used to analyze the light spectra emitted by a plasma during an etch process. The main advantage of OES is that it is a whole wafer technique, requiring no alignment of individual wafers, and tends to be lower cost than interferometry options. However, this method requires a stop layer, or differing layers. When the exposed area is small or the different layers are similar in composition then the change in the emission intensity is also small and can be difficult to detect.

❷ Claritas™

Claritas™, a patent protected technology (Patent US 9159599 B2) from SPTS, extends the use of existing OES options available on SPTS etch modules and enhances the detection of reactants and/or by-products. It allows end-pointing for applications even with low exposed areas (down to 0.05%) or "high pressure" processes that operate in the 100mTorr range. Claritas™ can be used for most Si etches to a stop layer as used for MEMS and TSVs (vertical via-last).

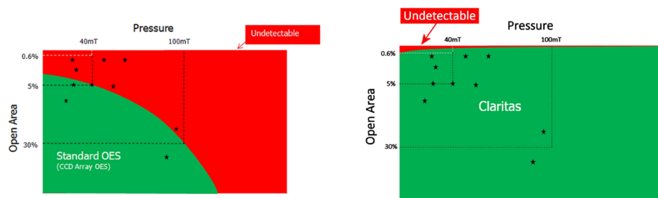

Fig. 2 Graphs illustrating enhanced capability of Claritas™ for low exposed area and/or high pressure processes

❸ ReVia®

ReVia® is a unique (Patent US 8709268 B2) end-point technique for in-situ monitoring the "via reveal" etch process. It detects the emergence of the vias during the backside etching of thinned wafers, in "via-middle" 3D-TSV packaging applications. It is capable of successful end-pointing even at remarkably low (<0.01%) via densities, and can save time and minimize yield loss in volume manufacturing.

❹ Near Infra Red (NIR)

The NIR technique uses the transparent nature of silicon to infra-red to monitor the change in wafer thickness during a silicon thinning process. With reflections off buried layers, or the opposite face of a silicon wafer, this approach can be used to end-point the thinning etch at a target thickness within 45μm of the reference surface.

❺ White Light Reflectometry

Reflectometry (and interferometry) relies on an external light source which is directed onto the wafer. The reflected light is detected and analyzed. If there is a stop layer with a different reflectivity then there will be a clear end-point signal produced. Reflectometry can be used for tapered TSV via-last etches.

❻ White Light Interferometry

Incident light will transmit through the wafer and be reflected from the interfaces between the layers, and the bottom of the etch feature, as well as from the top surface.

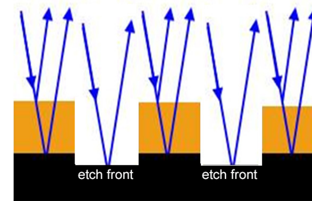

Fig. 3 Principle of Reflectance Interferometry

These reflected beams will interfere with each other, either constructively or destructively, creating a sinusoidal intensity signal with periodic oscillations called "fringes". The number of fringes will change with the changing depth of the etch front and mask thickness as it etches away (while the mask-wafer interface remains fixed), thus enabling real-time depth control and a measure of mask selectivity.

❼ Sentinel™

This unique end-point technique is used for the dicing-after-grind application where the wafer is mounted on a tape suspended from a frame. Sentinel™ detects the point where the tape has been reached during the plasma singulation step allowing process conditions and overetch to be modified for the completion of the process. Sentinel™ also provides protection for the substrate through the ability to monitor the conditions of the substrate and prevent damage to the tape and wafer.

❽ Parameter

System datalogs monitor many parameters of the etch process & process module including pressure, platen temperatures, RF matching, Vpp etc. In some cases, these parameters will react in the event of some change on the wafer, e.g. etch front reaching a cavity, allowing helium backpressure flow to escape or changing stress on wafer. The datalog can be used to monitor for these changes as the etch progresses triggering end-point as required.

SPTS Technologies, an Orbotech company, designs, manufactures, sells, and supports etch, PVD, CVD and MVD® wafer processing solutions for the MEMS, advanced packaging, LED, high speed RF on GaAs, and power management device markets. For more information about SPTS Technologies, email enquiries@spts.com or visit www.spts.com

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