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FAST TRACKING PROCESS DEVELOPMENT

A Case Study

An enhanced lab environment equipped with enhanced thin film characterization and measurement tools is the perfect way to help our customers speed up their new process development. Evatec CTO **Marco Padrun** and ECL Manager **Dominik Jaeger** show us how the ECL is already "earning its keep" using a recent case history analysing "Front Side Metallization" processes on 300mm.

Front Side Metallization - when particle control is a given

CLUSTERLINE® 300 is already well established in the market for 300mm metallization processes in both Power Device and Wafer Level Packaging applications, but as our customers need to achieve increasingly tough particle specifications, a detailed understanding of the potential sources of particles and the identification of appropriate remedies is essential.

The new Evatec Competence Laboratory (ECL) with its suite of characterization instruments including the latest particle measurement equipment is the perfect environment to take on this challenge.

> **HELPING OUR CUSTOMERS FAST TRACK THEIR PROCESS DEVELOPMENT IS OUR GOAL**
>
> Dominik Jaeger, ECL Manager

THE ECL IS WHERE WE WORK TOGETHER WITH OUR CUSTOMERS, HELPING THEM GROW

The ECL explained

Watch Evatec CTO, Marco Padrun explain the significance of the ECL and the benefits it brings to Evatec's customers'.

Step 1

Keeping the environment itself under control

It all starts with the lab itself. Clean processes need a clean basic environment and the ECL was designed for just that with operation at ISO 6 and lower. Background particles are monitored 24/7 at three different fixed locations across the lab so we can see any irregularities. Additional mobile equipment is also used to gain even better understanding of air flows and potential sources of the smallest particles.

Figure 1. shows that the background environment from the Evatec lab tracked over a series of several months. The overall performance is ISO 4 standards for most of the time.

Figure 2. shows the particle sizes and densities allowed for different cleanroom ISO levels.

Monthly cleanroom performance

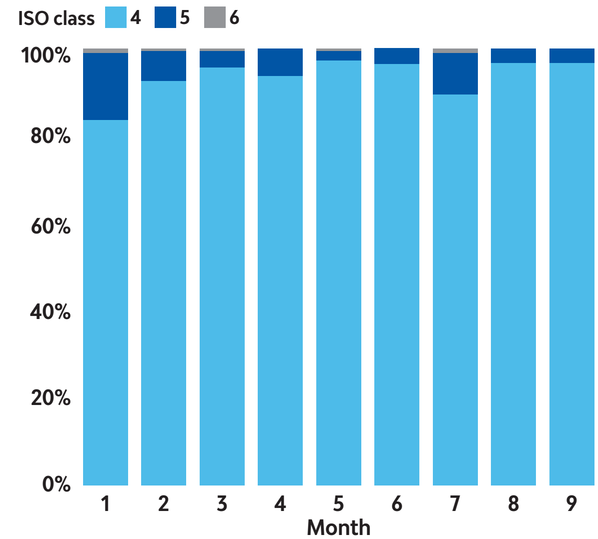


Figure 1.

	Particles per m³						
Old class	**≥ 0.1µm**	**≥ 0.2µm**	**≥ 0.3µm**	**≥ 0.5µm**	**≥ 1.0µm**	**≥ 5.0µm**	**New Class**
	10						ISO 1
	100	24	10				ISO 2
1	1,000	237	102	35			ISO 3
2	10,000	2,370	1,020	352	83		ISO 4
3	100,000	23,700	10,200	3,520	830		ISO 5
4	1,000,000	237,000	102,000	35,200	8,300	293	ISO 6
5				352,000	83,000	2,930	ISO 7
6				3,520,000	830,000	29,300	ISO 8
7				35,200,000	8,300,000	293,000	ISO 9+

Figure 2.

Did you know?

Typical densities per m³ for particles >1µm

Industrial cities
200 Mio.

Cities
100 Mio.

Countryside
10 Mio.

In the mountains, close to lakes
1 - 5 Mio.

In the ECL
< 100

Step 2

The right measurement equipment at the right place

Our particle detection instrument is perfect for analysis of particles down to the 50nm level and is housed within the ECL itself to eliminate risks associated with sample transport.

We use darkfield detection for opaque substrates where a laser with a very small spot size is scanned over a wafer rotating at high speed (figure 3). The light scattered by particles on the wafer surface is collected using mirrors and optical fibers. The amplitude of the scattered light can then be compared to a measured or simulated calibration curve to determine the particle size. The background noise is also compiled to a haze map, which corresponds to the surface roughness of the wafer. Typical outputs for the tool are illustrated in figures 4 and 5.

Figure 3. Particle detection by light scattering

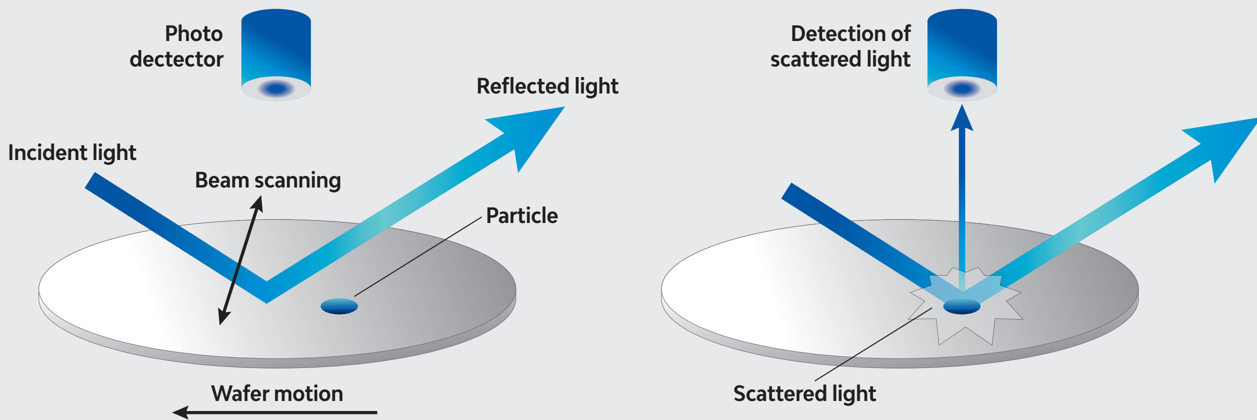


Figure 4. Typical particle map output file for a standard wafer

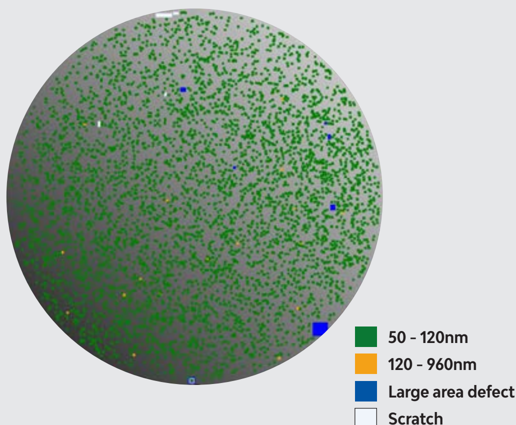
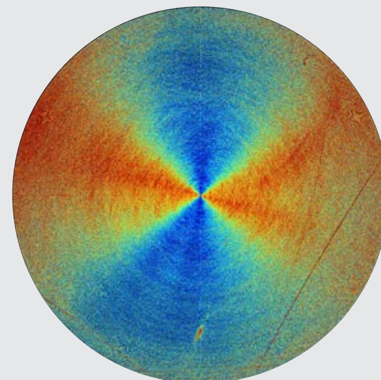


Figure 5. "Haze" map for a standard polished wafer – a measurement of surface roughness



Step 3

Know your deposition tool

Figure 6 shows the typical way in which we analyse the particle performance of a tool like the CLUSTERLINE® 300 for front side metallization processes. Even before the metallization process itself, the potential impact of each step of mechanical wafer handling, pump / vent or typical processes like degas can be assessed easily against the overall customer specifications. In this case we see that the particle specs for wafer handling were easily achieved.

Having such measurement tools is also a great way to identify and correct particle sources. In figure 7a you can see what happens after the sequence of a wafer transfer "in and out" of the process chamber if the chamber is not maintained correctly. In 7b you see the result after a thorough cleaning of the module that was identified to be the source of the particles. Checking wafers prior to handling in 7b also showed that most of these particles were also present even before the handling test.

Particles from handling are just part of the story

Handling is just one aspect to control. Additional particles and contamination can also be generated from process gas-lines and shieldings. "In-film" particles are also added during deposition. However, with over 20 measurement techniques already installed at the ECL we are confident that we can support our customers in whatever analysis they need now and in the future.

Particle control – a challenge in other applications too

Particle control is key not just for 300mm processes in power applications but in other Evatec core markets too. Processes for applications in wireless communication, MEMS, and LED on 150mm and 200mm wafers are also particle sensitive. Our ECL is equipped with deposition tools and analytical capabilities our customers need there too!

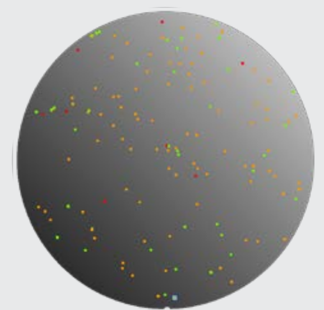
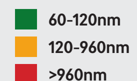


Figure 7a. wafer transfer "in & out" for an dirty module



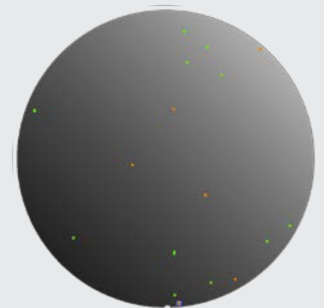


Figure 7b. wafer transfer "in & out" for a clean module – most particles already present on unprocessed wafer

			Particle count								
Slot	Progress Flow	Process	Pre >0.06µm	Post >0.06µm	Adders <45	Pre >0.12µm	Post >0.12µm	Adders < 12	Pre >0.96µm	Post >0.96µm	Adders < 2
1	AFEM	Handling	13	29	18	9	13	4	0	0	0
2	Aligner	Handling	13	17	4	0	0	0	0	0	0
3	IMA	Pump-Vent	8	13	5	1	2	1	2	1	0
4	IMB	Pump-Vent	11	12	1	4	5	1	0	0	0
5	SPM3 Ti	Handling	12	15	3	5	8	3	0	0	0
6	SPM3 Ti	Gas On	6	10	4	4	3	-1	0	0	0
7	SPM2 PVE	Gas On	9	8	-1	7	12	5	2	2	0

Specification / requirements: Class #1: <45 adders for size >0.06µm • Class #2: <12 adders for size >0.12µm • Class #3: <2 adders for size >0.96µm
AFEM: Atmospheric Front-end Module; IMA/B: Interface Module A/B; SPM: Sputter Process Module; PVE: Physical Vapor Etch

Figure 6.