300MM BACKSIDE METALLIZATION PROCESSES

Improved process control and productivity

The high demands on productivity and performance require the tailoring of process configurations depending on individual application needs. The versatile CLUSTERLINE® 300 PVD system for backside metallization provides dedicated configurations to optimize process results and cost of ownership. Temperature control through effective wafer cooling during deposition is a key element for this optimization. Evatec's **Gerald Feistritzer** compares the latest recessed chuck solution with electrostatic chuck (ESC) technology and demonstrates the benefits of a dedicated processing solution for thin wafers and TAIKO wafers.

The most advanced MOSFET and IGBT device architectures on ultrathin 300mm Si wafers require new levels of flexibility in equipment and process solutions for backside metallization as illustrated in figure 1.

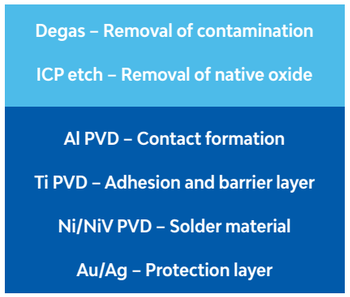

Figure 1: Typical backside metallization process sequence.

Besides the challenge of controlling the wafer bow and warpage by stress management of the layer stack, the flexibility to handle and process different substrate types is becoming more and more important. The range starts with ultrathin TAIKO Si wafers down to 60µm and continues with processing thin TAIKO wafer with tape to protect the frontside of the wafer, or alternatively the temporary bonding of Si wafers on glass with a total thickness of more than 1mm (typically with temperature limitations caused by the glue layer). Depending on the maximum allowed temperature, thermal mass of the substrate, stress, wafer bow restrictions and stress-sensitive film properties of the layer stack, CLUSTERLINE® 300 provides a solution for all these configuration options highlighting the leadership of Evatec in the power device market for backside metallization.

Managing wafer temperature and bow

Backside metallization in typical IGBT and MOSFET applications calls for deposition of thick multimetal stacks, typically Al, Ti, Ni/NiV and Au/Ag on thin 300mm wafers.

Prerequisites for processing of such high value wafers where the front side is complete with finished devices are:

- Appropriate handling of wafers without front side contact to prevent scratching / damage
- Secure highspeed handling of thin / bowed wafers
- Temperature control to prevent device damage and/or further wafer bow

Controlling the wafer temperature is not only critical, because high temperatures might create yield loss on the finished devices, but also to keep the stress of deposited films as low as possible. Stress is tuneable for most materials, for NiV for example, by pulsed sputtering and the addition of N2 gas. Keeping process temperatures low during deposition for stress control is a highly effective method for all metals, since high temperatures during deposition creates tensile thermal stress after cool-down. CLUSTERLINE® features in-situ pyrometer measurement in the PVD modules to monitor and control wafer temperature during deposition.

Increasing throughput for recessed chuck technologies

Evatec's recessed chuck solutions are well known for reliable processing of highly bowed wafers without damaging the front side. Careful process management including waiting steps is a production proven technique to avoid device damage due to overheating. However, for customers looking to improve throughput without compromizing on processing temperature CLUSTERLINE® 300 can also now be delivered with enhanced cooling options where heat exchange between wafer and chuck is increased using convection cooling.

The CLUSTERLINE® 300 with recessed chucks offers two different possible process solutions for implementing such enhanced cooling for 300mm wafers. Both are based on increasing the thermal contact with the wafer by gas convection cooling.

In so called "recessed backfill" configuration, additional argon process gas is introduced to the whole chamber in the short wait steps between sputtering to support cooling and is then pumped away prior the next sputter step (Figure 2a). An alternative configuration in figure 2b, - so called

	Process configuration			
	Recessed backfill	Recessed backgas	Recessed backgas (high T)	ESC with tape
Total process time (s)	520	381	317	310
Throughput (wph)	7.0	9.4	11.0	11.6
Wafer temperature in °C	168	169	192	90

Table 1: Throughput in wafers per hour (wph) and wafer temperature measured by Pyrometer for different process configurations. Ni deposition 1050nm, acceptable wafer bow for 120µm TAIKO: <4mm.

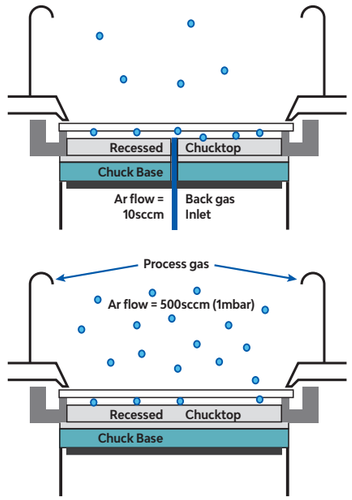

Figure 2: Comparison between recessed backfill and recessed backgas

"recessed backgas" - shows how gas is introduced via an inlet through the chuck base – the so called backgas line – to enhance the cooling step. In this configuration effective cooling can be achieved with less gas and in less time.

Figure 3 shows how the temperature quickly falls during each cooling step in a typical nickel metallization process on a 120 micron TAIKO wafer when with backfill gas.

ESC vs recessed chuck technology

ESC technology with backgas offers excellent control of bow and wafer temperature while avoiding damage to the front side. An effective solution uses polyimide tape either on the wafer frontside or directly on the chuck surface. Evatec has demonstrated the excellent performance of both options on ESC based on specific customer requests.

Figure 4 shows the process temperatures measured and process times achieved for the same nickel deposition process on 300mm TAIKO wafers using ESC and different recessed chuck set ups (backfill or backgas).

We see that all solutions allow for important process performance improvements. Throughput can be enhanced using recessed chucks in either backfill or backgas configuration at a given process temperature without increasing the wafer bow. We also see how wafer throughput can be increased in production even further without impacting the bow if customers' processes allow for slightly higher peak wafer temperatures. The capability of the ESC solution to cool the wafer constantly during deposition provides the highest throughput at the lowest possible process temperatures.

Depending on the end device requirements a recessed chuck or ESC offer the best solution. Key parameters are the maximum wafer bow, substrate temperature, expected throughput and cost of ownership. With our many years of experience and servicing some of the biggest power device manufacturers in the industry we are ready to help you to find the ideal solution for your own particular needs.

The way ahead

Backside metallization is well established, but these improvements on our CLUSTERLINE® 300 can help further improve processes and their throughput. Contact us at info@evatecnet.com to find out more about our capabilities to boost performance and productivity for backside metallization.

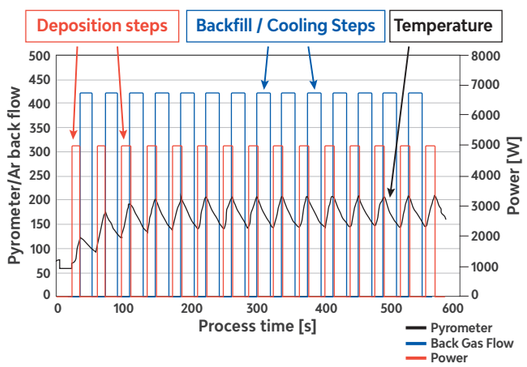

Figure 3: Temperature behaviour for a recessed backfill process.

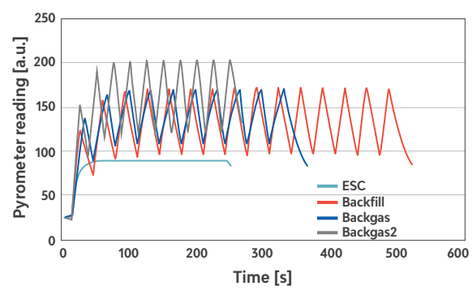

Figure 4: The comparison of different chuck configuration.