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Volume 38 Issue 3 2016 @siliconsemi www.siliconsemiconductor.net

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AN ANGEL BUSINESS COMMUNICATIONS PUBLICATION

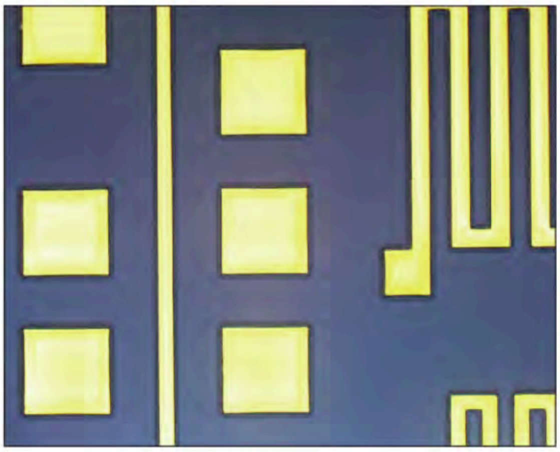
REDUCE GOLD USAGE

Nothing surpasses gold's inherent semiconductor performance benefits. But ClassOne Technology explains how its electroplating system can keep performance high at a fraction of the cost.

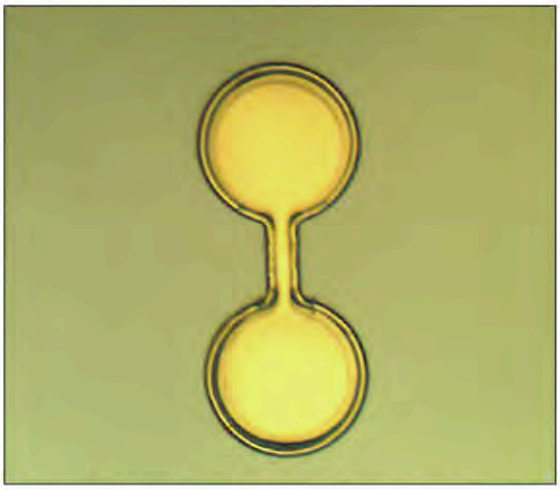
GOLD, despite its high cost, has long been an essential element in semiconductor processing because it is a highly efficient and reliable electrical conductor that also resists oxidation and corrosion. These qualities make gold ideal for connectors, switches and relay contacts in a vast array of applications, which is why in 2015 the electronics industry used more than 290 tons of this precious metal.[1] However, a newer generation of electroplating tools is starting to reduce that usage in certain sectors.

Addressing the problems of PVD, CVD and wet bench deposition

In semiconductor processing, gold is often deposited by physical vapor deposition (PVD) and chemical vapor deposition (CVD) methods. While those techniques sufficed for a time, they also brought certain significant problems such as material wastage, slow deposition rates and downtime for necessary equipment cleanings. Some have tried to use wet benches for gold plating, but with limited success due to the high non-uniformity inherent in that approach. Also, manually operated wet benches were prone to undesirable levels of variation and the risk of human exposure to open baths of toxic chemistry.



Gold plating by the Solstice S8 system



Many semiconductor applications require gold layers ranging in thickness from 3 to 35 microns

However, a newer generation of electroplating systems, exemplified by the Solstice family from ClassOne Technology, is designed to overcome those limitations. The systems provide fast, waste-free, cost-efficient, and production-oriented solutions with uniformities in the 1 percent range.

Eliminating gold loss, reducing gold expenditure

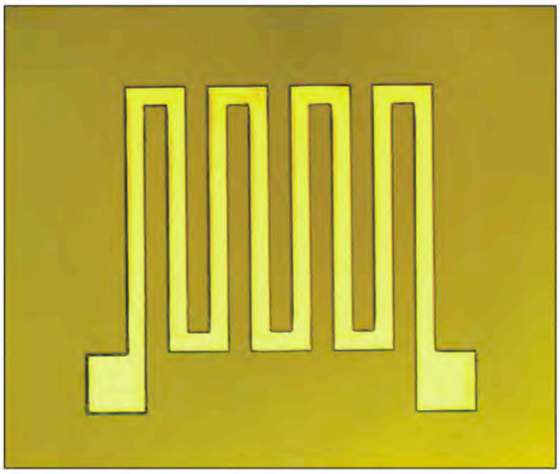
For gold deposition, one fundamental challenge with PVD and CVD was that those techniques did not coat just the wafer, they also coated the entire inner surface of the deposition chamber — in this case, with a very costly material. Theoretically, the 'oversprayed' gold could be recaptured and reclaimed. But in practice, cleaning and reclaiming processes have proved to be very difficult, time-consuming, potentially dangerous (perhaps requiring the use of hazardous chemicals such aqua regia) and ultimately inefficient. Consequently, a great deal of the oversprayed gold was permanently lost, which significantly increases the total cost of ownership of the process.

By contrast, new electroplating systems only deposit gold onto the wafer, specifically where it is needed. There is no 'overspray' or waste of gold. Also, there is no equipment downtime for chamber cleanings and no need for reclamation efforts. The new electroplating process is cleaner and simpler; it is also more precise and efficient. It reduces costs substantially by cutting gold usage and eliminating waste. The amount of gold needed is further reduced by the fact that electroplating is a self-purifying process, so it requires only four nines of purity in the electrolyte solution instead of the six nines required in evaporation pellets or sputtering targets.

Faster deposition, more streamlined processing

In addition to the gold loss problem, PVD and CVD processes have also been limited by relatively slow deposition rates — typically between 10 and 30 nm/min. This had been acceptable for creating relatively thin layers; however, as applications began to require thicker gold layers, the long deposition process times became increasingly problematic. Today, many emerging markets such as lasers, LEDs, RF and MEMS have requirements for gold layers as thick as 3 to 35 microns, so manufacturers are actively seeking faster deposition solutions.

New Solstice electroplating systems provide deposition rates in the order of 150 to 300 nm/min, or roughly 10 times faster than previous deposition methods. In addition, the new tools are specifically designed for ≤200mm wafer processing and are thus strategically positioned to serve the needs of many emerging markets that use smaller substrates.

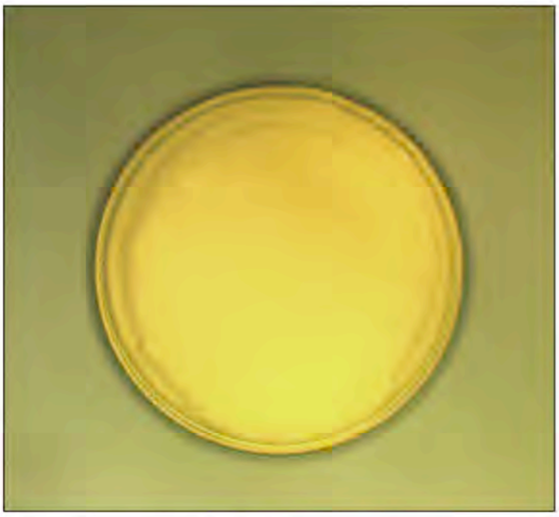

The Solstice S8 can electroplate device features, reducing the amount of pure gold needed by up to 10 times


A view inside ClassOne Technology's Solstice S8 electroplating system showing the tool's eight processing chambers

New electroplating tools further reduce cycle times because no vacuum is required, so processing can start immediately. There is no pump-down wait time before processing can begin. Also, one wafer can be run at a time if desired, without incurring any overhead penalty. The resultant savings in time and increased throughput can add a further level of cost efficiency.

Innovative layering technique can reduce gold usage substantially

Because of its unique 8-chamber design the Solstice S8 electroplating system enables it to replace a solid gold layer with a multi-metal stack, and use much less gold than would otherwise be required.
For example, a feature that previously required a 5μm layer of solid gold can be replaced with a 'sandwich' of 0.25μm Au, 1μm Ni, 2.5μm Cu, and another 1μm Ni – all topped with 0.25μm Au – to achieve equivalent functionality while reducing gold usage by a factor of ten. The multi-chamber equipment design enables it to deposit the Au / Ni / Cu / Ni / Au layers all in a single cycle; no additional process steps or time are



Gold contact points made of an electroplated 'stack' using Au, Ni and Cu instead of pure gold

required to gain significant cost savings.

The magnitude of potential gold savings can be estimated by extending the example above: Assume that a fab is running 1,500 wafers per week through a metal lift-off process where 5 μm of gold is deposited over 50 percent of a 150 mm wafer area. Further assume that all oversprayed gold is recovered and that the price of gold is $1200 per troy ounce with no additional processing fees for the purity.

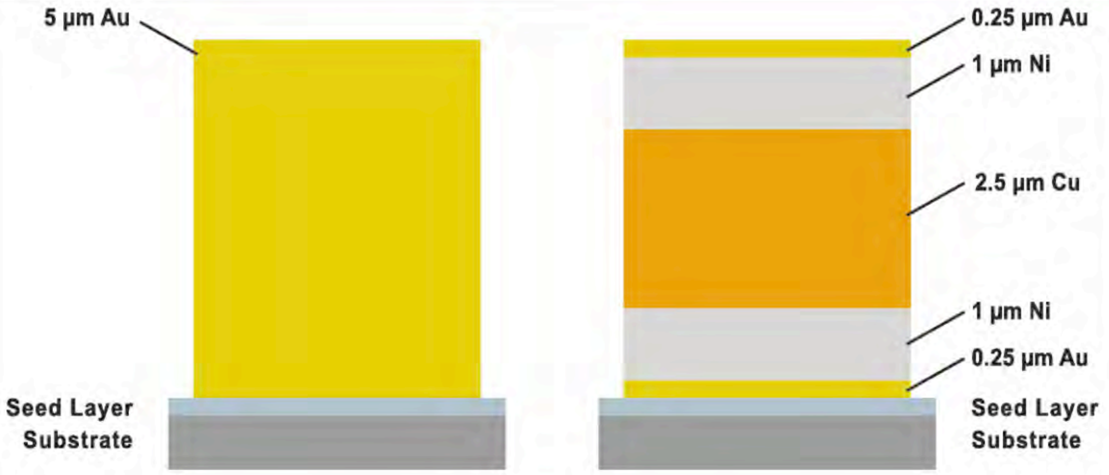
Under those conditions, using a solid gold layer, the user's annual gold cost would be approximately $2,150,000. However, with the same operational assumptions, if the Solstice's Au / Ni / Cu / Ni / Au 'sandwich' technique were used, the total deposited metal costs (Au + Ni + Cu) would be reduced to just over $108,000 per year — yielding an annual savings of over $2,042,000. Thus, the gold cost reduction in the first year alone would more than pay back the cost of the electroplating tool! And if gold were to rise in price, the payback would be reached even more quickly.

Substantially reduce costs while increasing performance

In summary, Solstice electroplating systems are able to deposit thicker gold layers more quickly and efficiently while eliminating gold waste. The process requires no downtime for cleaning vacuum chambers, and it provides increased uptime and more cost-efficient processing. Perhaps most significantly, the tool's chamber design enables innovative layering techniques that can potentially yield enough reduction in gold usage to pay back the equipment purchase cost within a year.

Solstice is a registered trademark of ClassOne Technology.

Reference
1. World Gold Council, (www.gold.org)



Multi-metal stack (right) can reduce gold usage by up to 10x compared with solid gold layer (left).

A side view 'cut-away' illustration showing the composition of an electroplated device feature that uses 10x less gold than a pure gold analog