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ABF Substrates

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Companies: Ibiden, AT&S, Unimicron, Infineon, Nittobo

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A Core that Integrates All the 'Hottest' Components

Our recent finding reveals that Ibiden and AT&S have begun to invest heavily in substrate core capacity in preparation for multilayer cores for embedding passive and active components in GPU accelerators. We think the implications are: 1) core layers account for 10% of substrate costs, so an increase to 6-8 layers will drive ASP; 2) CCL will remain the dominant core material, so recent market chatter about glass core adoption could be overhyped; 3) substrate suppliers' embedding technology could be an important factor. Our top pick among substrate stocks is AT&S, and we think there is upside to its recently announced €1.5-€2bn investment.

Ibiden and AT&S both are investing heavily in substrate core

Ibiden's recently released YUHO reveals a ¥120bn expansion in substrate core production in Penang (included in its JPY500bn capex plan). Coincidentally, AT&S also announced the construction of a dedicated substrate core plant in Kulim. We believe that Ibiden and AT&S's new core capacity expansion is to address multi-layered cores (vs. the current two-layer structure) to embed capacitors and inductors, as well as IVRs (integrated voltage regulator). As TDP (thermal design power) increases, PMIC technology needs to evolve to provide higher power density and reduce power loss arising from heat from PDNs (power delivery network). Bringing the PMIC closer to the xPU core – from lateral to VPD (vertical power delivery) then IVR – further reduces the PDN loss. Companies like Infineon, Renesas, and Murata have been talking about embedding trends, and we are finally seeing the first concrete steps for all the 'hottest' component topics – MLCC, PMIC, and substrates – coming together in the core.

Embedded technology execution could be a key factor

nVidia and AMD are the first adopters of multi-layered cores due to high TDP for GPU accelerators. We think the trend towards multi-layer core technology has the following implications: 1) a typical two-layer core accounts for 10% of substrate costs – this will increase to 3-4x as the industry adopts a structure with up to 6-8 layers; 2) embedded components are likely to be consigned, so does not improve substrate ASP, but execution of embedding could be a key factor given the different skill set, as well as risks of a low yield rate that could be a drag on margins; 3) T-glass based CCL will continue to be the dominant material, and ABF layers are not reduced on the back of an increase in core layers; 4) adoption of recently much-discussed glass cores remains elusive.

AT&S will likely raise capex further

AT&S recently announced a €1.5-2.0bn capex plan that includes spending for Kulim 1, Kulim 2, and the construction of a new substrate core plant. But given Ibiden's planned €650m investment in substrate core expansion, we think there is upside to AT&S's capex plan. We think Kulim 2 production is likely to be allocated among Intel, AMD, and ASIC clients. Within Kulim 2, we think Intel is likely to account for 60-70% of the capacity for EMIB-T and general server CPUs. We had previously estimated that Intel mostly funded AT&S's investment in EMIB-T in Kulim 2 - likely to have been in the €300-400m range (vs. Ibiden's €1.1bn equivalent investment). But we now think that AT&S' capacity build-out is likely larger – its EMIB-T capacity could be ab
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Substrate core takes center stage

Recall that in February 2026 Ibiden announced ¥500bn in equipment investment over the next three years for ABF substrate capacity expansion, of which ¥220bn was slated for the Gama plant (include overseas expansion), and ¥280bn was slated for the Ono plant (include overseas plants). On a closer examination of Ibiden's FY3/26 YUHO (equivalent to SEC Form 10-K), which was released two weeks ago, we were surprised to find a ~¥120bn investment in the Malaysia plant. The total of the three major investments (Gama, Ono, Malaysia) adds up to close to ¥500bn, but the amount slightly differs, in particular for the Ono plant. Ibiden's Malaysia plant was first set up for SLP (substrate like PCB) production for Apple's iPhones but has been converted to substrate core production in recent years, and we believe that the planned Malaysia investments is to increase substrate core production to support the Ono and Gama plants' future needs. This also clarifies what Ibiden meant when it lumped 'overseas expansion' into the total capex.

FIGURE 1 – IBIDEN'S PLANNED INVESTMENTS IN FY3/26 YUHO

Plant	Planned investments (JPYm)		Date of start of investment	Planned finished date
	Total amount	Already paid		

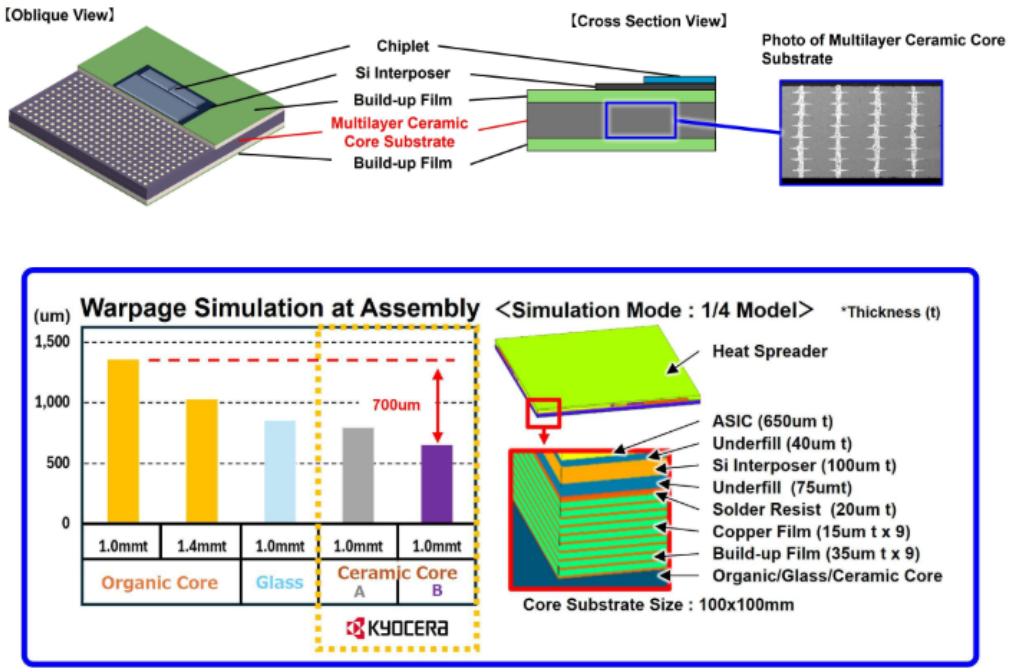
Source: Company data, Aletheia Capital/TAG

Coincidentally, AT&S's recent announcement to fit out Kulim 2 (cleanroom and equipment needs to be installed) also includes a side comment on the construction site for IC substrate cores and advanced PCBs. We believe that this is a dedicated plant for core production that will be located at the Kulim sites, but details are still unavailable. Furthermore, looking at the amount of Ibiden's investment in Malaysia, we think there is upside to the €1.5~2.0bn investments that AT&S announced.

The next generation core technology has three different routes (and could also be different combinations):

1. Adoption of different core materials such as glass or ceramic. R&D on glass core technology has been going on for more than a decade since the 2010s. We have previously written on this subject, but to summarize, glass core offers advantages in warpage, enables finer line/space and thermal efficiency, and enables higher power delivery for high currents through more usage of copper. But glass production process is difficult to handle (and may not be done by substrate companies), and our checks indicate no major demand in the next three years. Kyocera also recently announced a multilayer ceramic core substrate.

FIGURE 2 – KYOCERA'S CERAMIC CORE OFFERING



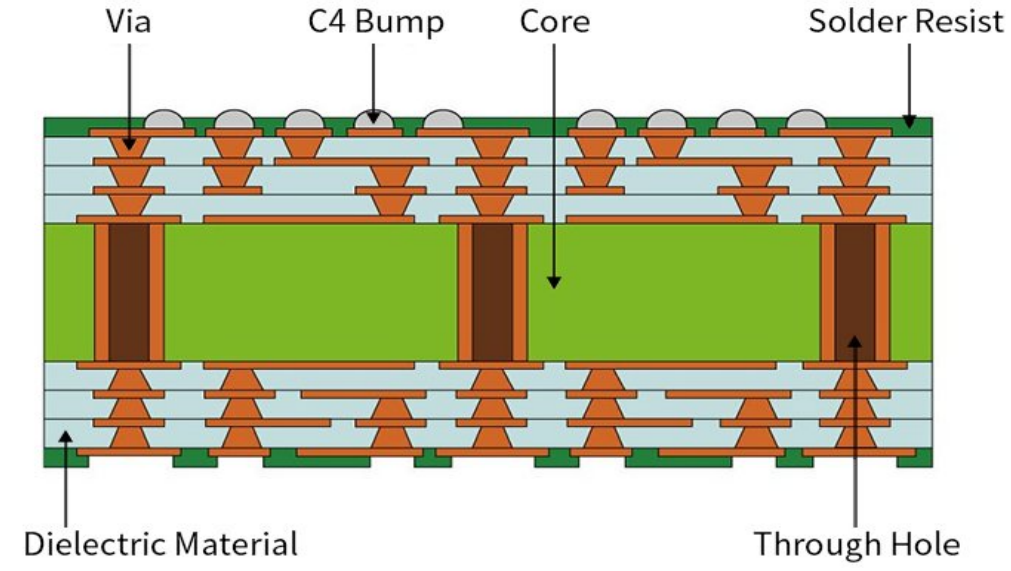
Source: Kyocera

2. Passive component embedding. This is already used in some ABF substrates as well as Apple's M-series chips to incorporate MLCC and deep trench capacitors (silicon capacitors).

3. Multi-layer structured substrate core – leveraging the available space in the core to embedding active components (that is, semiconductors) as well as passive components.

We believe that Ibiden's and AT&S's new core capacity expansion is to address the multi-layered cores that will play an important role in the future. Most of the substrate cores (over 90%) currently in the market are a simple two-layer structure, and this is shifting towards a multi-layered structure to 6-8 layers (or more).

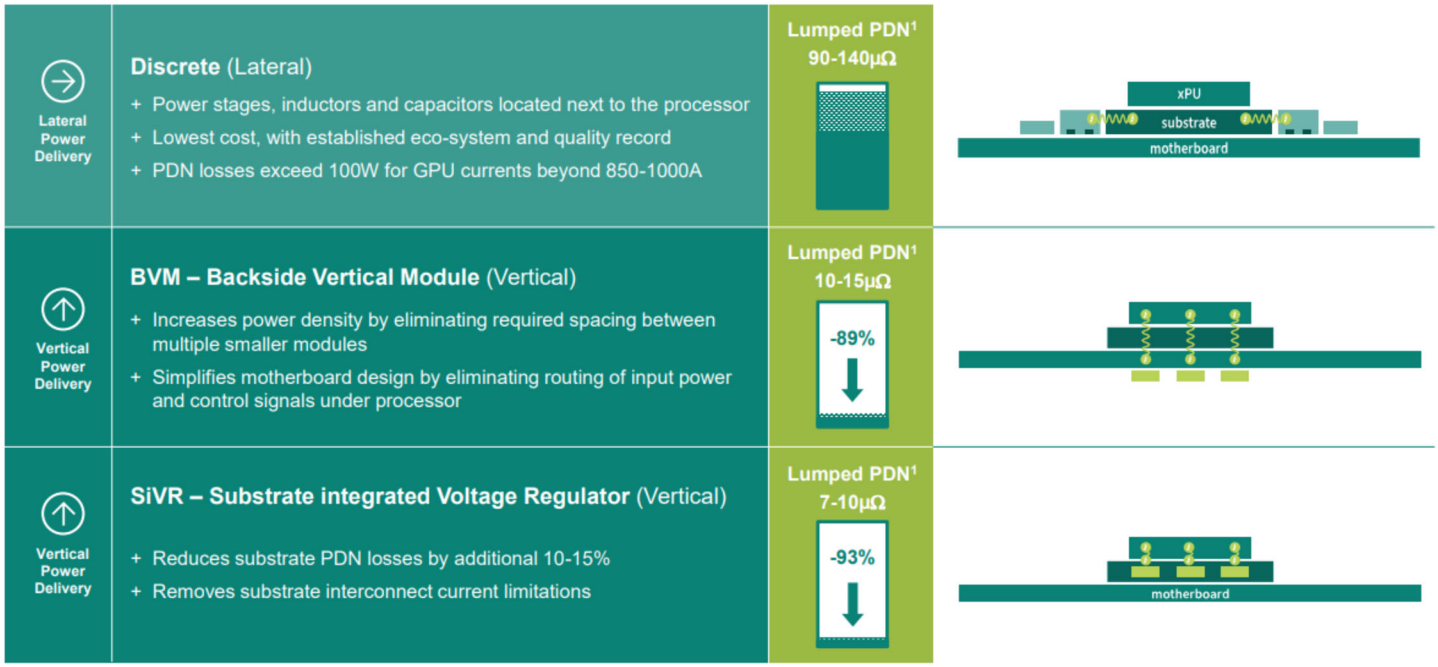
FIGURE 3 – A SIMPLE DIAGRAM OF TWO-LAYER CORE



Source: Shinko Electric

We have written extensively on the evolution of power delivery to the core (xPU). As TDP (thermal design power) increases, PMIC technology needs to evolve to provide higher power density and reduce power loss arising from heat from PDN (power delivery network). Bringing the PMIC closer to the xPU – from lateral to VPD (vertical power delivery) then IVR (integrated voltage regulator) - can reduce the PDN loss further, as demonstrated in the figure below.

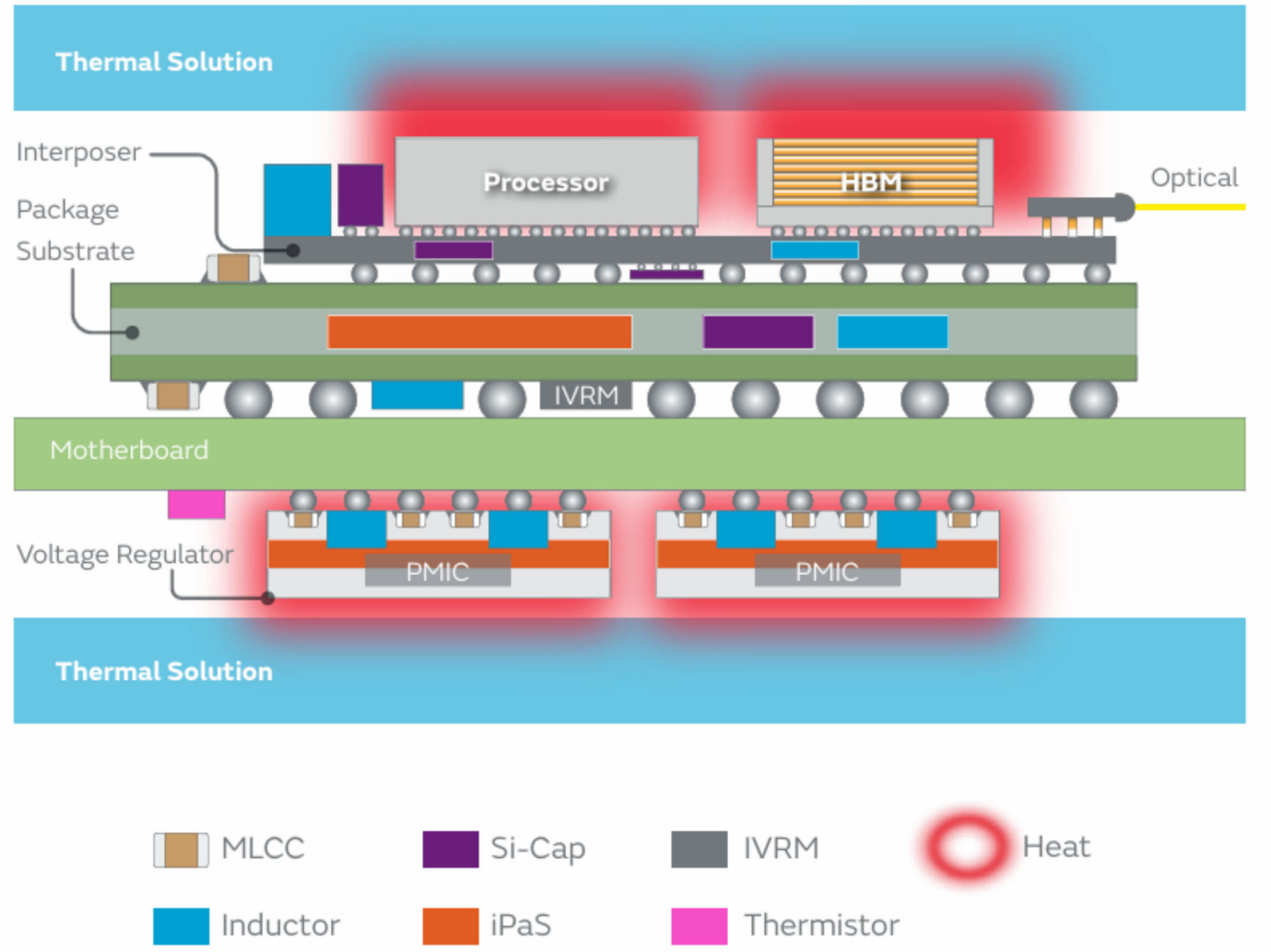
FIG 4 – PMIC TECHNOLOGY EVOLUTION FROM LATERAL TO VPD AND TO IVR



Source: Infineon

Murata has a similar diagram but in slightly more detail. The main functions of core layers are to provide rigidity to the substrates as well as enable signals/currents to pass through. The multi-layer structure to embed active components requires more complicated circuit connections, as well as a cheaper solution (vs. glass) to support a higher current requirement through more copper usage.

FIGURE 5 – MURATA'S SOLUTIONS FOR POWER DELIVER TO THE CORE



Source: Murata

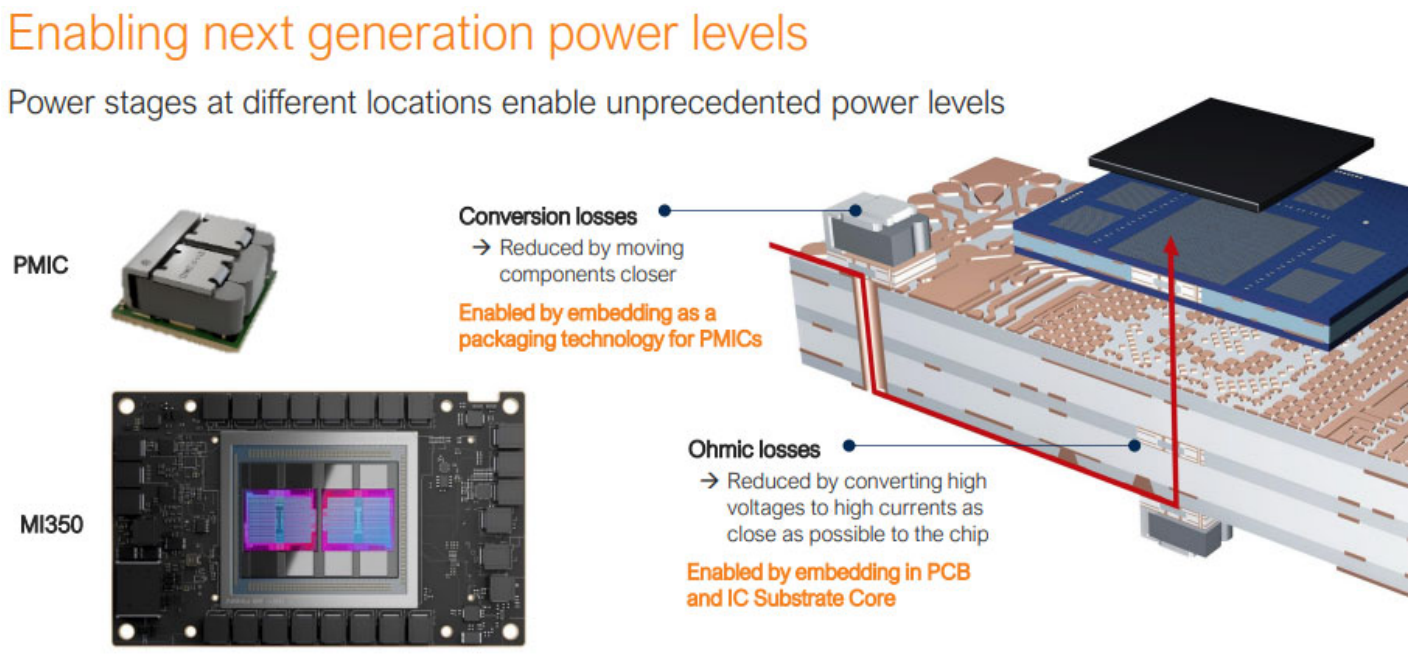
Implications for the supply chain

We think the shift towards a multi-layered core has the following implications:

- **Accretive to ASP.** Core layers account for about 10% of the cost of ABF substrates, so a higher core layer count is positive to substrates' ASP.
- **Embedded components are likely to be consigned.** Selection and price negotiations for the embedded passive and active components are to be determined by the clients, so the component costs are likely to be consigned.
- **ABF layers are intact.** There were some concerns in the initial stage about whether ABF layers will be reduced as cores take up a more important role, but this does not appear to be the case as chiplet architecture becomes more complicated.
- **Nittobo's T-glass based CCL will still be the main material for multi core,** until the industry shifts to alternative materials such as glass or ceramic. Again, our checks indicate no visible demand in the next 2-3 years for glass core adoption.
- **Early adopters of multi-layered cores appear to be nVidia and AMD for respective GPU accelerators.**

We think the technology to embed components within CCL-based material is key. Suppliers such as AT&S have historically produced a patented ECP (embedded component package) technology that embeds active and passive components in the core with laser-cut cavities. The technology was introduced 20 years ago for embedding SSD cards, and saw wider adoption in GaN modules to GaN Systems (now Infineon). Based on that relationship, we believe AT&S is the sole supplier of ECP-based PCB to Infineon's VPD, so ECP is a proven technology in volume production. The process for multi-layer core appears to be similar to that of ECP.

FIGURE 6 – AT&S' ECP PRODUCTS FOR POWER DELIVERY



Source: AT&S

Upside to AT&S' €1.5-2bn capex plan

While AT&S indicated that the €1.5-€2.0bn capex plan it announced includes spending for Kulim 1, Kulim 2, and the construction of a new substrate core plant, we think it is likely to announce additional capex, in particular for the core plant (Ibiden plans to spend €650m on core production in Malaysia).

We think Kulim 2 production is likely to be allocated among Intel, AMD, and ASIC clients, and Kulim 1 will be a dedicated AMD plant. Within Kulim 2, we think Intel is likely to account for 60%-70% of the capacity. We had previously estimated that Intel had mostly funded AT&S' investment in EMIB-T in Kulim 2, likely to have been in the €300-400m range (vs. Ibiden's €1.1bn equivalent investment). But we now think that AT&S's capacity build-out is likely to be larger – its EMIB-T capacity could be about one-half the size of Ibiden's planned investments. Market share among the potential EMIB-T suppliers is still unclear, as Shinko is no longer listed (so information is unavailable). We believe that Unimicron is investing in EMIB-T, given its disclosure on May 4 that it placed orders for NT$1.3bn (US$42m) of Toray Engineering's bonder alignment tools. The invested amount by Unimicron is not large, but we need to continue to monitor whether this will increase.

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