

India

Overweight (no change)**Highlighted Companies****Kaynes Technology****HOLD, TP Rs3120, Rs2721 close**

The company continues to focus on a low volume, high-mix business with specialized product offerings for higher margins. The revenue visibility is on track with its order book at Rs30bn (2.7x FY23 revenue) and margin of ~15%. However, a significant run-up in the stock price doesn't provide valuation comfort.

Summary Valuation Metrics

P/E (x)	Mar24-F	Mar25-F	Mar26-F
Kaynes Technology	105.18	67.46	47.97
P/BV (x)	Mar24-F	Mar25-F	Mar26-F
Kaynes Technology	6.89	6.25	5.53
Dividend Yield	Mar24-F	Mar25-F	Mar26-F
Kaynes Technology	0%	0%	0%

EMS**OSAT: India's journey is going to be tough**

- For OSAT companies to succeed in India, continued government incentives are key or else economic profit generation is going to be tough.
- The landscape of OSAT industry is changing with more and more R&D being conducted, as Moore's law reaches its limits.
- We feel Indian companies must quickly transition from being commoditized low-end players to oligopolistic high-end players or else survival will be tricky.

OSAT is not the 'low hanging fruit' as perceived by many

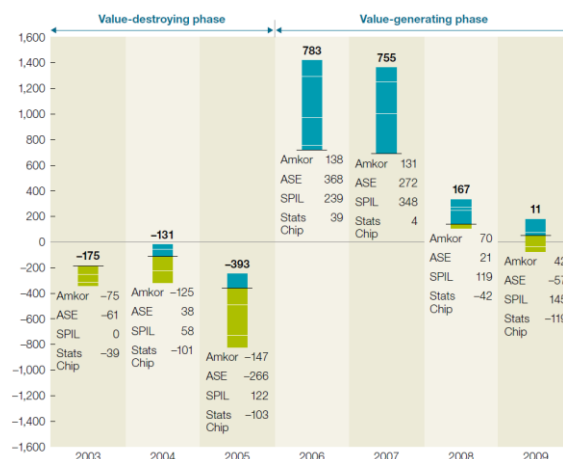
For India's entry into the semiconductor space, OSAT was considered as the low hanging fruit as it didn't involve much technical expertise, and also India could exploit the labour arbitrage when compared with other Asian countries. However, this is not going to be the case. Traditionally, OSATs didn't incur much R&D expenses as there was no such need. Companies were focusing on shrinking the size of the chip, and there was not much research being done on packaging those chips closely. As Moore's law becomes redundant, with every passing year, companies are realizing that shrinking the size of the chip is not going to be cost-effective. Hence, they are increasingly focusing on packaging those chips closely. This is resulting in companies incurring huge R&D expenses to stay at the leading edge of chip packaging. As a result, even foundries are entering the OSAT space as they realize that traditional OSATs haven't done enough R&D to stay at the forefront of chip assembly.

CG Power's transition to advanced packaging is going to be difficult

CG Power has tied up with Renesas and Star Microelectronics to set up an OSAT plant in Gujarat. We believe CG Power will mostly be entering the traditional packaging space, where wire bonding and flip chip are the prevalent technologies. We also need to understand that Renesas already has tie-ups with Powertech (OSAT company from Taiwan) and TSMC for advanced-level chip packaging. These two companies have roughly 20% of the advanced chip packaging market. In fact, TSMC is the market leader globally in the advanced packaging space. Moreover, Renesas doesn't seem to have much expertise in the advanced packaging space, as is visible with its lack of patents in the same.

Indian OSATs will be in the value-destroying phase ex-subsidies

We believe that it's going to be very difficult for Indian companies to generate returns greater than the cost of capital in the medium term without subsidies. Hence, government must provide subsidies going ahead if India has to get a chance in the OSAT space. In the not-too-distant past, outsourced semiconductor assembly and test (OSAT) companies were regarded as low-end, commoditized service businesses, and the competitive dynamics of the business were driven by price competition. This had a negative impact on the economics of the industry. Between 1996 and 2006, the sector, cumulatively, posted no significant economic profit. After that, the market was segregated into oligopolistic high-end players and commoditized mainstream players, and the faster Indian companies make this transition, the quicker they will be able to generate value for their shareholders.

Figure 1: Transition of ASE/AMKOR from the value destroying to the value generation phase

SOURCE: INCRED RESEARCH, COMPANY REPORTS

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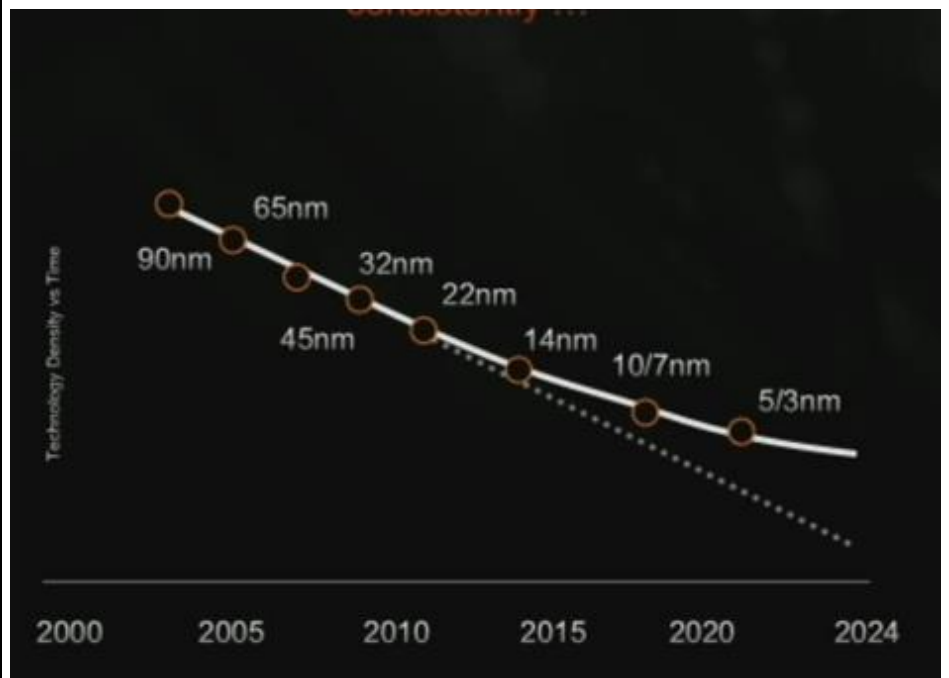
OSAT is going to be a tough nut for India

India has two companies setting up OSAT plants currently - TSAT (Tata Semiconductor and Test) establishing a plant in Assam and CG Power's Dholera, plant in Gujarat. However, we believe the OSAT journey for Indian players is not going to be easy. As Moore's law reaches its limits, foundries like TSMC and IDMs (integrated device manufacturers) like Intel are entering the OSAT space. This means rising competition for traditional OSAT players as they must also compete with foundries now. This will result in rising consolidation for OSAT players, as the players investing in R&D will survive and those at the bottom of the pyramid will either get acquired or face bankruptcy. OSAT is a notoriously capital-intensive industry with relatively poor return ratios and only the fittest can survive. In such a case, the OSAT and semiconductor industries can be pretty closely linked with the innovator pharma drug industry.

The global OSAT landscape is changing as Moore's law reaches its limits ➤

The famous Moore's law which states that 'transistors' on a chip should double after every two years, is gradually slowing down. This is because the cost advantages associated with shrinking transistors are evaporating. As a result, companies are increasingly looking for other avenues to expand the chip productivity. This translates to investing in more advanced packaging techniques.

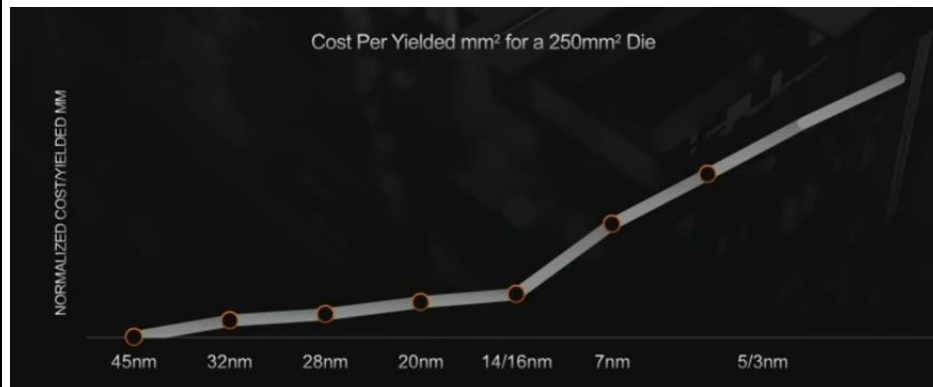
Figure 2: Moore's law has been slowing post 22nm (nanometer) node



SOURCE: INCRED RESEARCH, COMPANY REPORTS

While each node transition isn't equal, it's clear that at 7nm and 5nm, the industry has hit an inflection point. Rather than minor cost increases per yielded mm², there have been major cost increases.

Figure 3: Costs increase due to shrinking of chips



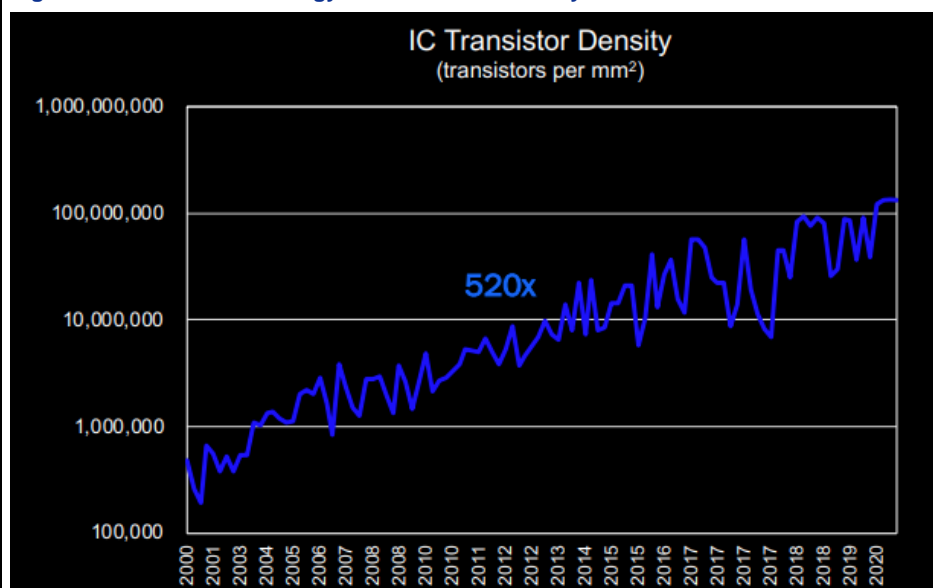
SOURCE: INCRED RESEARCH, COMPANY REPORTS

Even with these limitations, as the chipmakers continue to shrink, the expectations are that in some time, manufacturing a chip at smaller nodes would become unviable. This is a logical conclusion because each successive node adds ~35% more process steps. When leading edge processes measure in the thousands of process steps, errors start to stack up quickly.

If chips stop getting smaller, what is the solution? It's OSAT ►

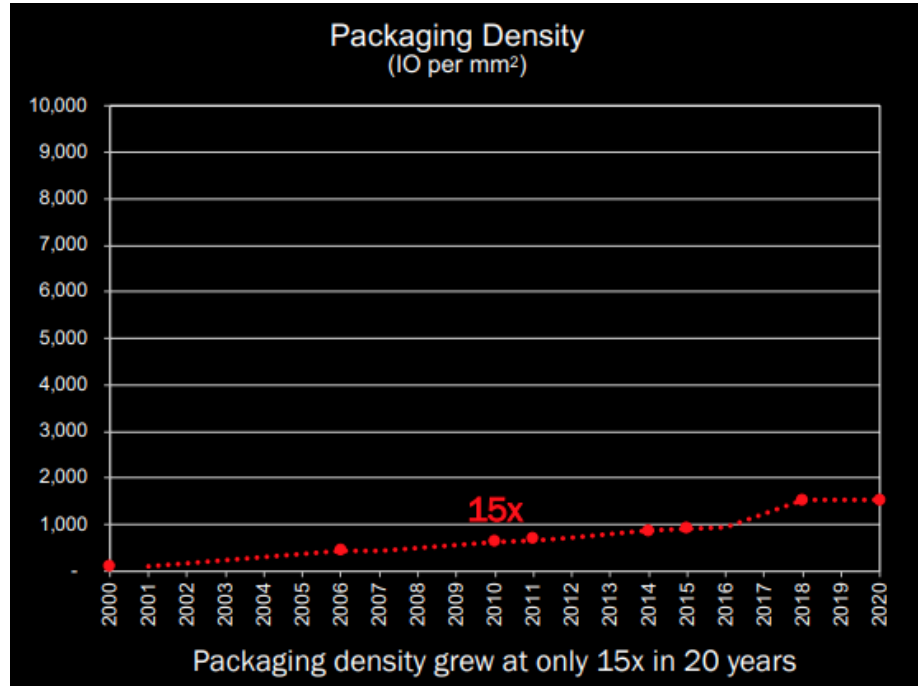
As the fabrication of integrated circuits or ICs reaches its limits, global chipmakers are resorting to newer packaging techniques to improve chip efficiency (yield). OSAT is the relatively lower value part of the semiconductor value chain and Taiwan & China hold a major portion of the market in this space. Labour arbitrage and cheap access to utilities act as key differentiators. Now, if chips themselves can't be shrunk further, then the only possible solution is to package them more closely. Let's take a very basic example to understand this: Let's say due to a global apocalypse, no chip manufacturer can manufacture a 7nm chip, then what can be done. A possible solution is packaging two 14 nm chips so closely and densely that they function like a 7nm chip. To enable this sort of packaging, R&D is required, which ensures that the process is cost-effective, and the system is efficient. Hence, advanced packaging has relatively higher entry barriers.

Figure 4: IC device technology advances 520x in 20 years



SOURCE: INCRED RESEARCH, COMPANY REPORTS

Figure 5: Packaging density has severely lagged transistor density

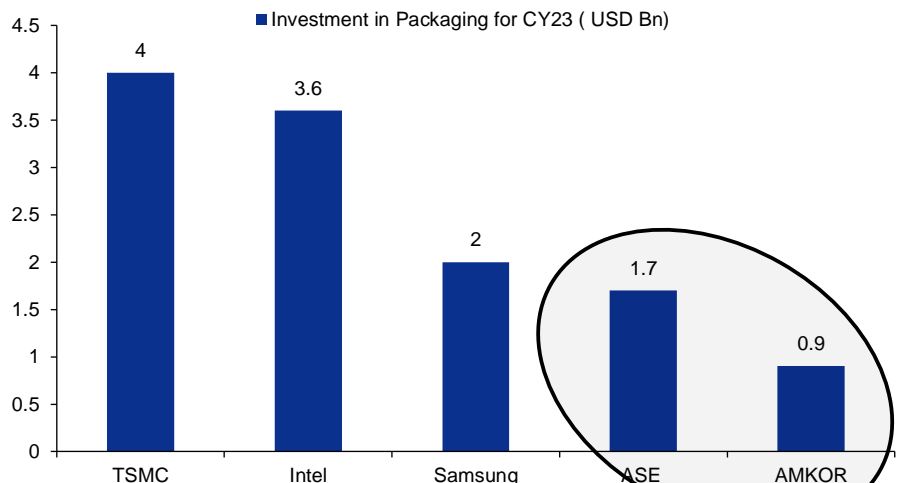


SOURCE: INCRED RESEARCH, COMPANY REPORTS

Foundries like TSMC are entering the OSAT space, but why?➤

Now global chipmakers have started realizing that shrinking chips won't add much economic value in the coming years. Hence, they are venturing further into packaging those chips closely, i.e. OSAT. However, there is a fundamental problem with the OSAT industry. OSAT players, barring the industry leader, do not spend a lot on R&D. They are more focused on utilizing the labour and utilities arbitrage. As a result, global OSAT players are nowhere near the packaging standards required for small nm chips. To meet the demand for advanced packaging methods, OSATs need to invest in appropriate capacities and tools, which are expensive. They cannot keep up with Intel, TSMC, and Samsung regarding investments in advanced packaging facilities. Last year, Intel spent US\$4 bn on advanced packaging plants, and TSMC's capital expenditure on advanced packaging totaled US\$3.6bn. In contrast, Samsung spent around US\$2 bn. By comparison, the capital expenditure of ASE Group (with SPIL and USI) totaled US\$1.7bn whereas the spending of Amkor touched US\$908m.

Figure 6: ASE and AMKOR, which are industry leaders in the OSAT space, are investing far less than foundries when it comes to chip-packaging capex

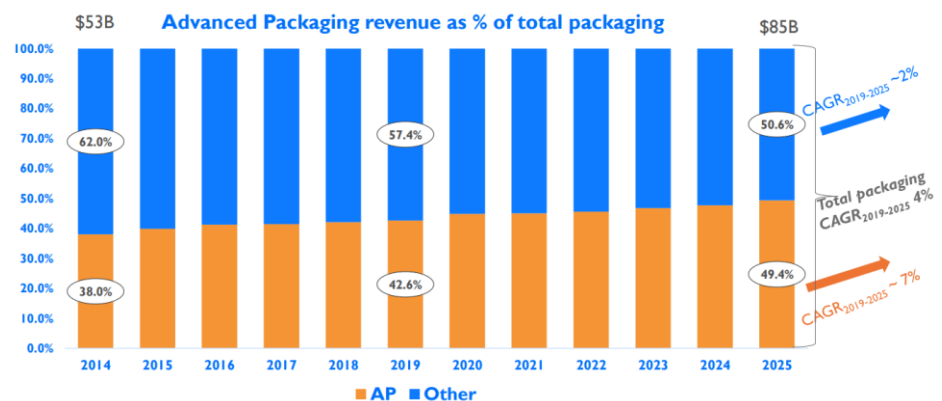


SOURCE: INCRED RESEARCH, COMPANY REPORTS

Brief details about packaging techniques - traditional vs. advanced ➤

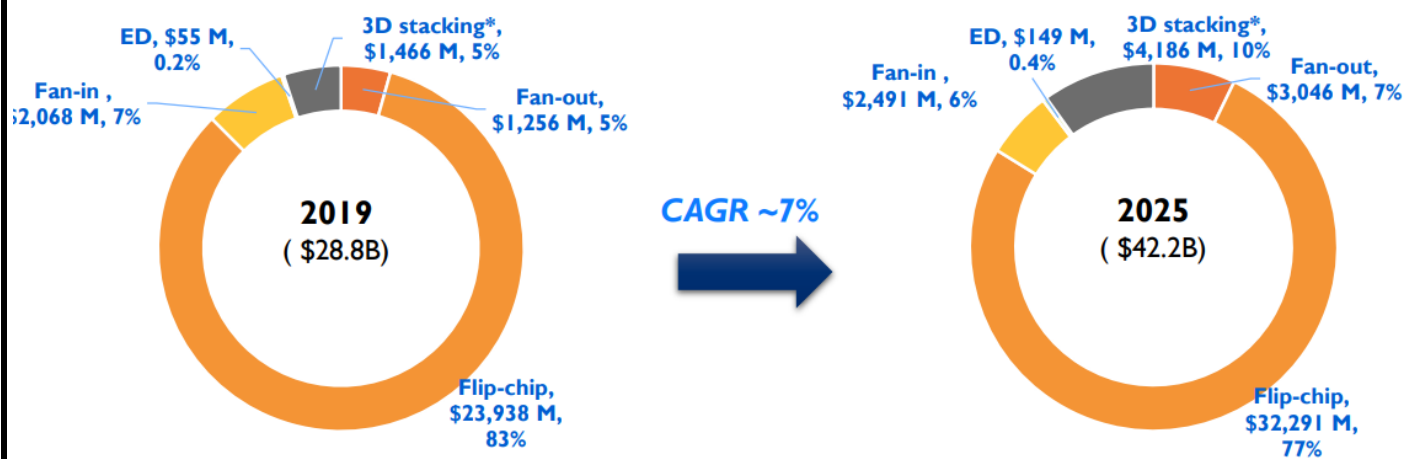
Traditional packaging generally involves wire bonding and flip chip whereas advanced packaging includes wafer-level packaging, 2.5D, 3D stacking. A major portion of R&D happening today is in the advanced packaging space. Traditional packaging has been growing at a modest CAGR of 2% over the last five-to-six years and this trend is expected to continue. The major growth trigger will be in the advanced packaging space, which is expected to post a CAGR of 10% in the coming years.

Figure 7: Advanced packaging has been taking away market share from traditional packaging



SOURCE: INCRED RESEARCH, COMPANY REPORTS

Figure 8: Advanced packaging revenue by technology; tech companies like Fan-Out and 3D Stacking are growing at a healthy CAGR of 16-20%

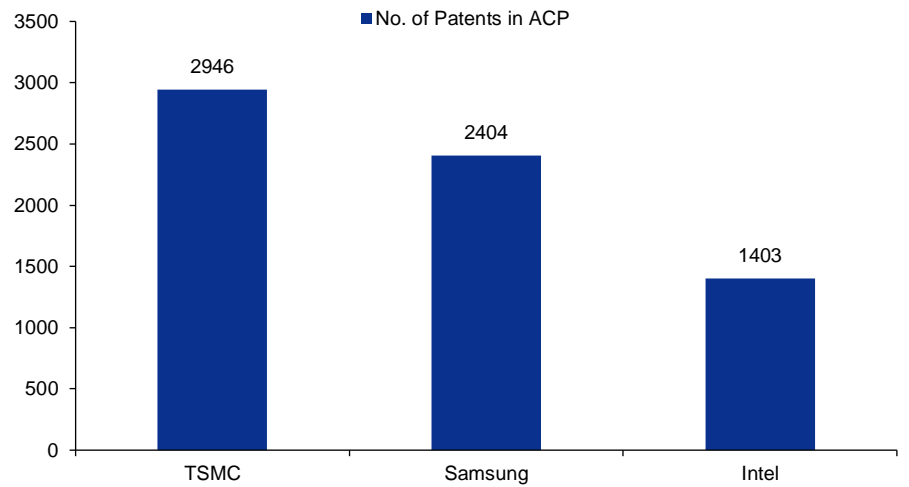


Flip-chip	CAGR ₂₀₁₈₋₂₀₂₅ ~ 5.9%
Fan-out	CAGR ₂₀₁₈₋₂₀₂₅ ~ 16%
Fan-in WLP	CAGR ₂₀₁₈₋₂₀₂₅ ~ 3.2%
3D Stacking	CAGR ₂₀₁₈₋₂₀₂₅ ~ 21.3%
Embedded Die	CAGR ₂₀₁₈₋₂₀₂₅ ~ 18%

SOURCE: INCRED RESEARCH, COMPANY REPORTS

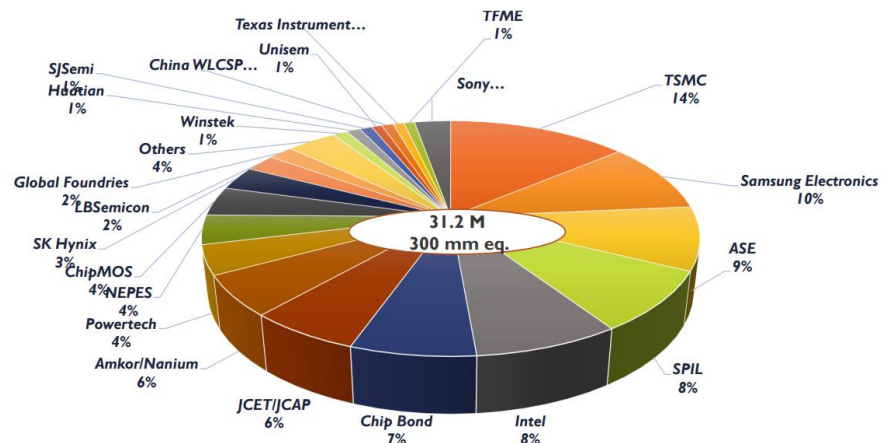
Foundries are cannibalizing the market share of traditional OSAT players ➤

Figure 9: TSMC and Samsung are way ahead in advanced chip packaging due to their rising patents



SOURCES:

Figure 10: 10 players, which includes 2 IDMs (Intel, Samsung), a foundry (TSMC) and the top 5 global OSATs process approximately 75% of advanced packaging



SOURCE: INCRED RESEARCH, COMPANY REPORTS

Figure 11: Foundries and IDMs are taking away market share from traditional OSATs

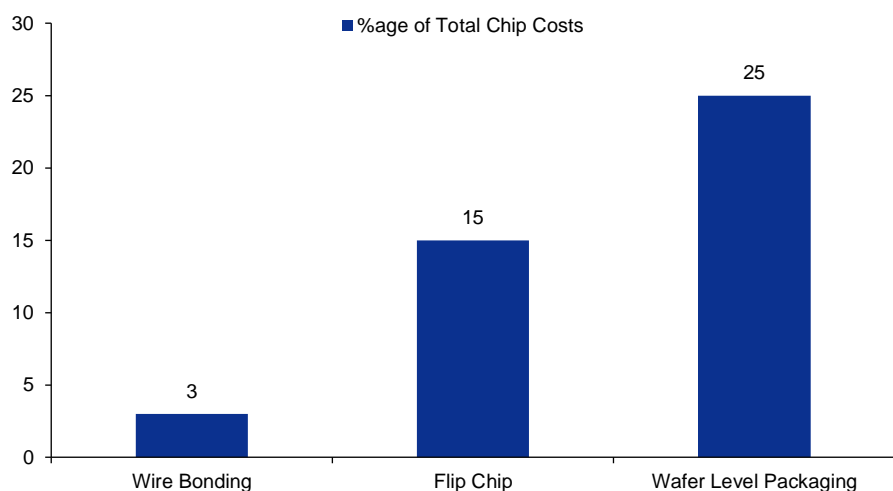


SOURCE: INCRED RESEARCH, COMPANY REPORTS

Advanced packaging accounts for a major chunk of chip manufacturing cost ➤

If we talk in terms of cost mechanics of a chip, the traditional chip packaging technologies like wire bonding account for a lower percentage of chip total cost whereas more complicated advanced packaging like 2.5D, 3D account for a higher percentage of a chip's total cost. In fact, TSMC's new advanced packaging tech CoWos (Chip on Wafer on Substrate) would comprise around 30-40% of the total chip cost.

Figure 12: Wafer-level packaging is the most cost-intensive chip packaging technology

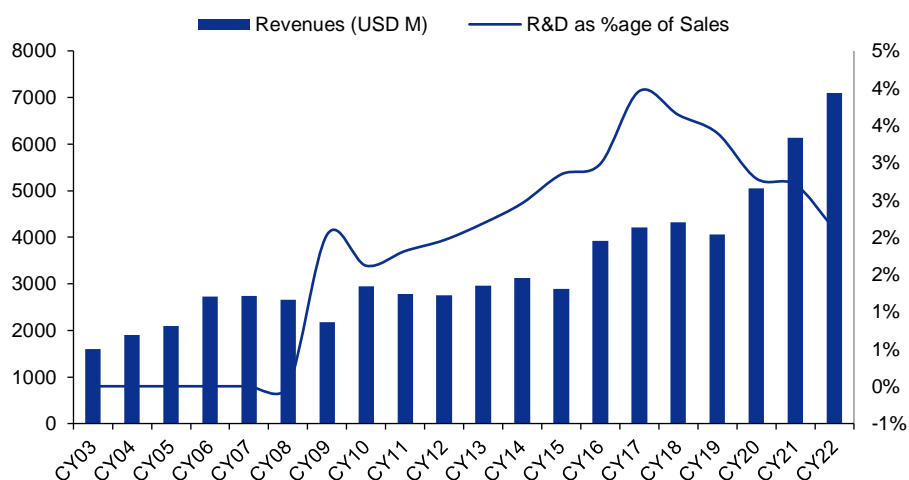


SOURCE: INCRED RESEARCH, COMPANY REPORTS

R&D is very important to crack OSAT and the US-based Amkor is a prime example ➤

Amkor is an US-based OSAT company mainly specializing in automotive-based OSAT. One look at its financials and we can realize the importance of R&D for OSAT companies. Research for OSATs generally can be divided into two parts: basic research and applied research. Basic research generally involves researching underlying concepts of physics and its theories whereas applied research generally involves a company optimizing its production process using different methods. Most of the research currently happening in the semiconductor industry involves applied research, as it is particularly difficult to copy and generally requires repeated iterations.

Figure 13: R&D costs are a prerequisite for revenue growth in the OSAT space - this trend is expected to become more pronounced with advanced packaging



SOURCE: INCRED RESEARCH, COMPANY REPORTS

Renesas already has partners for advanced packaging - Powertech and TSMC ➤

CG Power has tied up with Renesas and Star Microelectronics for setting up an OSAT plant in Gujarat. However, we need to note that CG Power will mostly indulge in lower-level wire bound packaging, as Renesas already has tie-ups with Powertech and TSMC for advanced-level packaging. In the early 2010s, Renesas began to increase outsourcing to foundries such as TSMC. Most recently, 30% of the Japanese company's semiconductors were manufactured externally. Moreover, Renesas doesn't seem to have much expertise in advanced chip packaging, as is visible with the number of patents. Hence, transitioning from traditional packaging to advanced packaging would be difficult for CG Power.

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