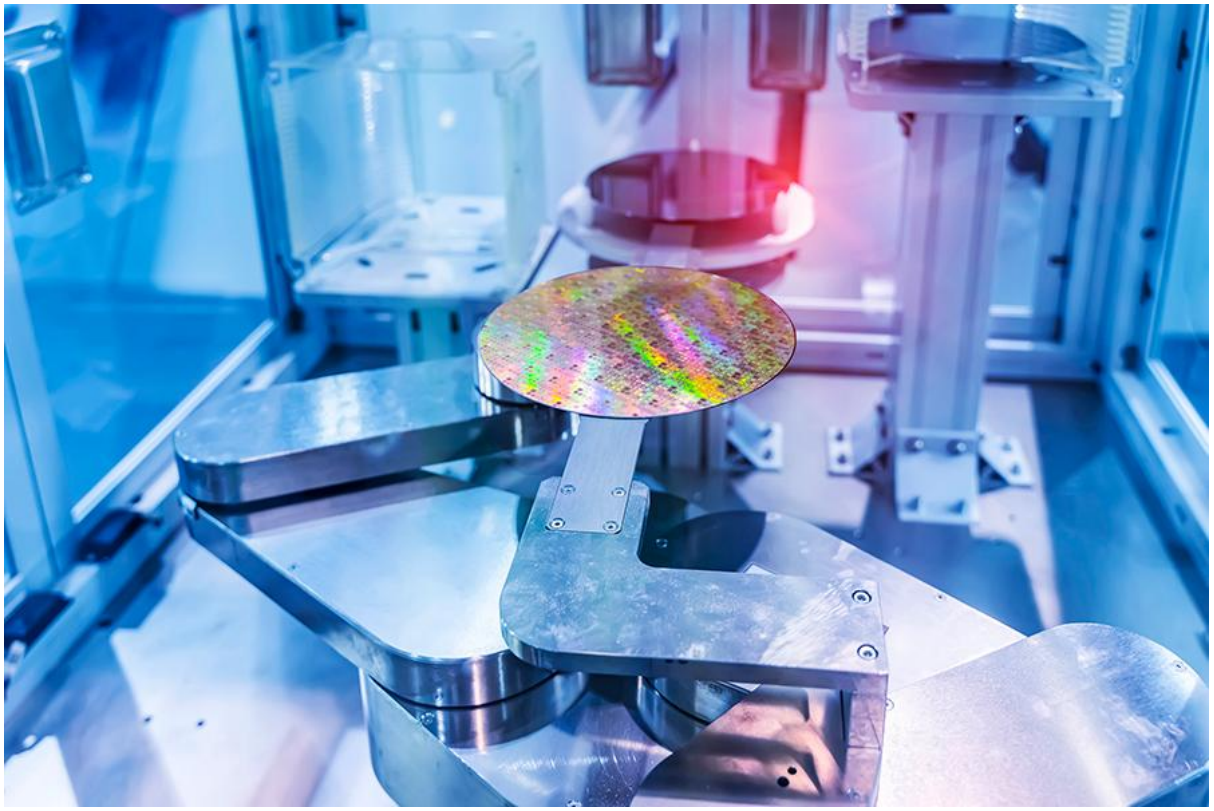
How to lay the solid foundation for semiconductor fabrication in India

By Anshuman Tripathy and Hariram Thirukarugavur Ramesh,| Jun 28, 2021

The time has come that India incentivises local industries to make indigenous semiconductor chips. Here's how PLIs and SLIs will help establish a new industry and meet the ever-increasing demand.



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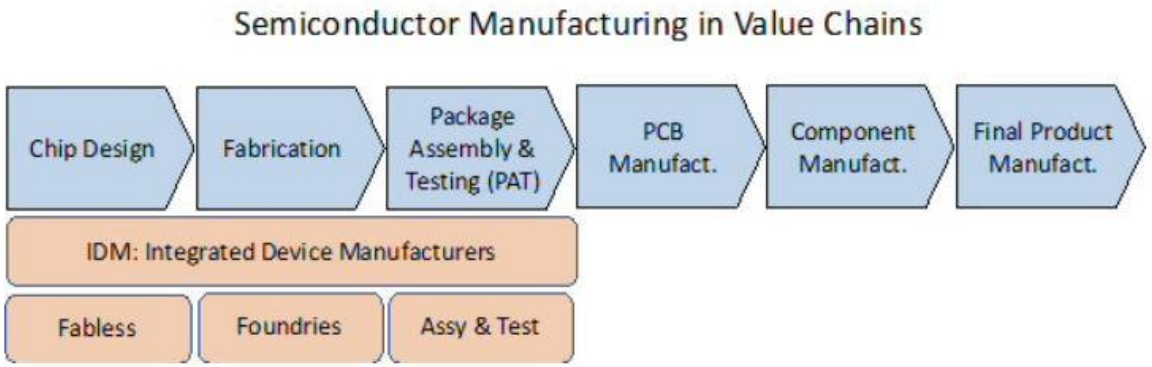
Covid-19 has brought about a lot of realizations across the world. While the focus rightly remains on healthcare, it would be futile to not pay attention to various other new challenges and be prepared for the economic upturn thereafter. One significant issue has been the shortage of semiconductors and how it has affected various industries, specifically automotive. As automotive demand dipped with the onset of the pandemic, auto companies

started cancelling their upstream orders. On the other hand, electronics product industries, riding on higher demand fuelled by work from home amongst, started increasing their orders and stockpiling. This cascaded into a massive front-loading of demand for chips and stretched capacities at foundries. When automotive demand did come back, the bullwhip effect resulted in acute semiconductor shortages and production disruption.

India imports 100% of its semiconductor needs (approx. $15 billion in 2020) with 37% coming from China (INDIAai, 2021). This demand is expected to increase to $32 billion in 2025 with the advent of 5G, and the growing incorporation and production of electronics in India—the electronics sector is expected to grow to $410 billion by 2025, growing to about 8.2% of India's GDP. This exposes India's vulnerability as their usage continues to grow across critical industries such as defence, automotive, consumer electronics, healthcare, and so on. With the added challenge of geopolitics becoming more confrontational, it has become imperative for India to secure various supply chains. The technology sanctions resulting from the United Nations Security Council's Resolution 1172 due to the Pokhran nuclear tests in 1998 serve as a grim reminder of the flipside of globalisation and lack of a strategic alternative in place. Such strictures particularly affect government organizations such as ISRO, DRDO, and so on.

_RSS_Semiconductor manufacturing is an upstream part of the value chain of various products. Post-manufacturing, the semiconductors are incorporated in printed circuit boards (PCBs) which then go into the final product (or a component of the final product) that is sold. While the last three stages of the value chain have been present in India, they are expected to grow phenomenally with the introduction of the Production Linked Incentive (PLI) scheme. We can only expect this scheme to expand beyond mobile phones, electronics, and components, automotive, pharmaceuticals, advanced chemistry cell batteries, and so on. This growth will only fuel the demand for semiconductors. How should this demand be met? Through continued imports? This leads us to take a deeper look at the upstream value chain, i.e. semiconductor manufacturing.

Semiconductor manufacturing consists of chip design, fabrication, and assembly and testing. Integrated device manufacturers (IDM) like Intel do all three. A modularized value chain also exists with specialists such as ARM, Nvidia, Qualcomm, Apple involved in chip design only and foundries such as Taiwan Semiconductor Manufacturing Company Ltd (TSMC) doing the chip fabrication (wafer processing). Package, assembly and testing is a labour-intensive process that is outsourced to low-cost manufacturing locations.



News reports suggest that the Indian government has proposed more than $1 billion in cash incentives to prospective companies that manufacture semiconductors in India, and further committing to be a buyer and possibly mandate private companies to also buy. The key question is—can this be done in India and what will it take to do it? Previous attempts have not fructified. However, given the financial incentives on offer now, perhaps there is a possibility.

As the Indian Prime Minister Narendra Modi said that the government has no business to be in the business of business, we believe that chip manufacturing is strategic and the Indian government agencies or local downstream manufacturers should not be limited by any international sanctions, trade limitations or supply chain constraints. It may be prudent for the Indian government to form a public sector joint-venture with a leading semiconductor manufacturer such as TSMC or Samsung that will bring in the technology. Such a joint-venture has the benefit of de-risking, control, and subject matter expertise. The partners would also be more inclined to invest because of the sovereign guarantee given the significant upfront capital expenditure.

The key part of this investment decision would be the node size and the wafer size. While 300mm is a widely adopted wafer size with available manufacturing equipment, the choice of node size is a difficult one. TSMC's 3nm factory is reported to have cost $19.5 billion whereas a 28nm factory is expected to cost $10 billion. Though the automotive industry has been primarily using 28nm (the electronics industry uses much smaller ones), there is a trend to go smaller as computing needs grow. We suggest a 10nm node process Fab which would cost approximately $15 billion. The Fab producing 100,000 wspm will be able to meet India's growing demand of 2025 and few years beyond, while keeping operating costs low and flexibility high. This will help meet the needs of various industries and given their local availability (and a lead time of about 3 years), the local Indian manufacturers may look to redesign their components to incorporate these chips. This fabrication unit can then be looked for retooling to smaller (advanced) nodes in later years.

Two questions remain unanswered: how to tool this factory? And why will the Indian manufacturers buy from this plant?

The often-cited approach of “copy exactly” should be adopted for tooling the factory—replicating an existing facility will ensure no yield loss right from the beginning. This will ensure that the manufacturing equipment—notably lithographic—are already developed and can be supplied from existing suppliers of the joint-venture partner. Similarly, the speciality chemicals—such as photoresists—can be developed with the expanding speciality chemicals industry in India.

Once such a factory is setup, it will be important to ensure that the output is sold. We propose that on the lines of the PLI scheme, the government introduce a Supply Linked Incentive (SLI) scheme that incentivizes local manufacturers to buy from this unit. This will help local manufacturers source the chips competitively and help boost volumes. A PLI scheme for the fab unit may not be as attractive because the product firms that benefit from PLI could be a few steps downstream in the value chain. On the other hand, a combination of PLI and SLI will create a powerful moat for various indigenous manufacturing units to attain global competitiveness. More than just the financial incentives, the availability of local manufacturing will further provide flexibility to the local ecosystem to innovate for more market capture. Also, such SLI schemes will ensure that the chip unit is incentivised to supply locally before any exporting.

Views expressed are personal

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