NEWSLETTER

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Guest Editorial

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Semiconductor Manufacturing in India

India has seen growth in consumer electronics as a business and market, especially so in the past 10+ years. TVs and music systems, and a growing awareness/need of white-goods seeded the initial growth in the 1970s. phones, etc in the 1980s and 1990s. The past decade has seen a growing demand and market for smart phones, intelligent vehicles, renewable energy (especially solar photo-voltaics), solid state lighting (LEDs), electronics in the healthcare sector, tablets, increasingly sophisticated displays, etc.

It is now accepted that India as a business and market in electronics is a growth sector – and this comprises semiconductors (chips, solar cells, LEDs), electronic boards and systems, packaging, displays, software, etc.

Some Statistics : Local electronics consumption is expected to touch $400 billion by 2020, which translates into a chip market of between $50 billion and $60 billion. Over the last two years, chip consumption has increased 61.44% to $8.25 billion. Right now, India imports 95% of its electronics with $45 billion worth of electronic goods imported in 2010. India adds value by way of design but that accounts for a more modest $2 billion. Moreover, $20 billion worth of chips are manufactured at Taiwan, China and Korea, based on chip design work done in India. These chips eventually go into finished electronics goods worth $60-billion plus. Each fabrication facility costs $4 billion to $ 6 billion. It may require significant R&D investments every 18-24 months to stay ahead in the technology.

SEMICONDUCTOR MANUFACTURING

As an important aspect of this ecosystem, semiconductor manufacturing is seen as a key aspect to help the growth in India. Earlier, besides some attempts, India did not see chip fabrication units (fabs) or semiconductor chip manufacturing foundries being set up for large scale production.

The SIPS (Special Incentive Package Scheme) more popularly known as the “Semiconductor Policy” was conceived in 2007 to help set up a fab in India. While this resulted in incentivizing a different aspect of semiconductor manufacturing (solar cell manufacturing); it did not result in the setting up of a fab or foundry for chips.

A revised version of the SIPS has been conceived to help make setting up of a fab/foundry, and a request for expression-of-intent has been sent out, with some positive responses received.

India is a vast “young” country with a growing middle class population and purchasing power. *There is a growing awareness and demand for consumer electronics (cell phones have been a major driver, along with TVs, white goods, automotive, diagnostics and health care, security driven smart cards, tablets, etc). There is also a need to drive towards “Made in India” products.*

To cater to growing need of chips, we must have:

- A Manufacturing ecosystem to manufacture the chips;
- Semiconductor chips used as signal/video/ general purpose processors, microcontrollers, memories, etc;
- Assembly, test, and packaging industry for the manufactured chips;
- Embedded/real-time software to run these chips;
- A supply chain to cater to all the critical equipment and chemicals;
- Trained technical human resources to
    - Run and manage the fabs,
    - Study the evolving the marketing and growth trends,
    - Analyze different and changing business models,
    - Understand the allied and global industries which form the supplier and customer base,
    - Understand and propose policies for the growth of the manufacturing sector, and related business in India,

- Carry out leading R&D

Important aspects of the business model:

- Cater to the growing demands semiconductor chips in the country, especially in the sectors of medical/health-care electronics, energy, automotive, industrial engineering, pharmaceuticals, etc
- Addressing the "bottom of the pyramid" needs lots of innovation to satisfy the increasingly-aware customer;
- Need for a "bottom-up" and "made for India" approach;
- Use the products which have become successful in India, and "exporting" them to various countries with suitable modifications;
- Have an outward/global vision, with a domestic seed/platform to prove success of the model;
- Have a necessary R&D infrastructure with very strong synergy between industry, academia, and government

It needs not just a clever management of resources, but more importantly a radical way to think differently, and see what is good and strategic for India in the long run.

In the analysis below, aspects of semiconductor manufacturing in India are highlighted, and a different perspective is presented which may be more feasible, and business viable, from the India perspective. It highlights the

- Key questions to be asked,
- Use of Indian growth industries to drive semiconductor manufacturing in India,
- Use of a) relevant technologies, and b) renewable energy as alternative routes for setting up semiconductor manufacturing in India,
- Recommendations

QUESTIONS RELATED TO INDIA SEMICONDUCTOR MANUFACTURING

Before getting into analysis and recommendations for fabs, and/or foundries, in India, it would be good to ask questions pertaining to this industry – specially, and specifically, from the Indian ecosystem point of view.

In the semiconductor industry food chain, India has architects, design, software, products, end customers. OEMs (Original Equipment Manufacturers) – along with targeted verticals like consumer, wireless, automotive, medical, etc.

What is missing is the semiconductor manufacturing, along with large scale presence and capabilities in ATMP (Assembly, Test, Marking and Packaging).

Setting up of fabs by IDMs (Independent Device Manufacturers), as well as foundries – will help set up an important missing link in semiconductor industry food chain.

While this will bring India onto the world map of manufacturing, and also help reduce the supply chain logistics/costs for local markets, certain important factors need to be addressed to help set the right strategy :

- Is it important to have the manufacturing setups at the leading edge technology (usually referred as Node-N)?
- If yes – is there a defined plan to stay on the leading technology nodes which changes every 18-24 months, with regular investments, at costs of $1billion or more?
- Will there be adequate funding for the increasing R&D costs for materials, processes, etc?
- If the fab is to be at older technology nodes N-2 (N-2 is read as "N minus 2, and refers to two technology nodes behind the present one) or N-3 technology nodes, will it be to address the analog, mixed-signal, RF, devices?
- What is the local market and industry being addressed - automotive, medical, etc?
- Should there be a preference to be N-2/3/4 technology nodes behind, and address the relevant growing markets such as automotive, white-goods, healthcare, etc?
- Should one concentrate on associated analog, mixed-signal, RF, etc which do not need the latest technology nodes?
- Does one stay with CMOS, or look at other semiconductor processes like GaAS, etc?
- Will the Indian fabs able to provide the necessary differentiation and value-add to the customers as compared to the more established fabs?
- What is the strategy to wean away the potential customers from the existing fabs/foundries?
- What is the business model to get a favorable RoI (Return-on-Investments), especially given the very low margins, as well as to compete with the excellent infrastructure set up by the Taiwanese? Are there plans to identify the steps to become profitable in reasonable time, and thus have a good RoI?
- Does the necessary infrastructure – transportation, logistics, power, chemicals, water, waste management, supply chain, secondary and tertiary suppliers/vendors exist, and what does it take to set them up?

- What industries do we plan to target, as potential customers of the fabs? Will the fabs cater to the growing solar, LED, healthcare, automotive, industrial, etc industries in India?

DRIVERS FOR INDIAN SEMICONDUCTOR MANUFACTURING

Factors to fuel the growth for semiconductor chips in India:

- The proven talent base in India,
- The growing customer base for semiconductors and electronics products,
- An increasing band of middle-class population with increasing capacity to purchase,
- Aggressive investor-friendly policies by various governments (central, and state),
- Increasing product ownership in India,
- Automotive/pharmaceutical/wireless/solar/LED/etc…. industries setting up their manufacturing plants in India, etc.
- "Made in India" product, with the appropriate technology and price-point

The above has helped create a mind-set which has made the industry and the government look favorably towards semiconductor manufacturing in India.

Given the above, as well as the success of the semiconductor design and services industry in India – it is but natural to think of semiconductor manufacturing as the next big step.

The parameters involved in setting up fabs and foundries for semiconductor manufacturing are quite unique and specific to this industry:

- High precision processes and equipments,
- Gases, chemicals, water, power,
- Supply chain of materials and chemicals,
- Government baking,
- Large capital investments,
- Environmental health and safety,
- Proximity to air and sea ports, and related transportation,
- Closer integration into the semiconductor food-chain,
- Growing demand for the semiconductor and electronic products in the Asia-Pacific region, etc

ALTERNATIVE PATHS TO BRING SEMICONDUCTOR MANUFACTURING IN INDIA

While there may be a good rationale for setting up the latest technology chips manufacturing fabs in India, there are two alternative paths to bring in semiconductor manufacturing into India:

A. Look at earlier technology nodes which are not the latest – these could be N-3 or more.

B. Via renewable energy route.

A. Earlier Technology Nodes:

Technology nodes essentially define semiconductor chip manufacturing – eg. a 22 nm (nanometer) node specifies the minimum feature size in the semiconductor manufacturing technology. An earlier node may correspond to 45nm, 65nm, 90nm, 130nm, etc.

Some of the advantages for following this approach are the following:

- The lower end technology nodes fabs do not need the latest and most sophisticated
  - equipments
  - infrastructure (clean rooms, etc)
  - process technologies
  - chemicals
  - supply chain
  - packaging technologies
  - etc

- The chips manufactured at these low end technology nodes will contribute to the following growth sectors in India:
    - Renewable energy: Solar, LED
    - Automotive
    - Micro-controllers, analog, mixed-signal, MEMS:
        - Healthcare
        - Sensors, Mobile/wireless diagnostics and treatment
        - Industrial: Electronics, Automation
        - FMCGs: All white good items
- The advantages are
    - The manufacturing equipments can be bought from the old fabs at depreciated rates, and can be refurbished for the target applications
    - There are no regular high recurring expenses (every 18 months) to jump a technology node, and keep up with the competition
    - There is no attempt to compete with the Asian manufacturers, but to set up an infrastructure needed for India
- Packaging of chips is an important aspect of chips manufacturing.
    - The technology nodes as defined above, does not need the latest packaging technologies (wafer level packaging, 3D packaging, etc)
    - The packaging facilities, and technologies needed, can be set up in India
- Once the manufacturing ecosystem is set up, and is successful as a business (market, customers, revenues, growth, etc) – it will yield a platform (and confidence) to go for high technology manufacturing (if needed)
- The supply chain logistics becomes simplified because
    - Local market and demand has been identified in India
    - Manufacturing is in India
    - ATMP (Assembly, Test, Marking, Packaging) can be done in India
    - Electronics/Boards ecosystem exists in India
    - EMS is a growing industry in India, and feeds into the semiconductor/electronics industry
    - Industries of critical importance to India's growth (healthcare, solar, LED, automotive, industrial, FMCGs, etc) are addressed \

B. Renewable Energy Route

Renewable energy sector can help drive the growth of semiconductor manufacturing in India. In particular – Solar PhotoVolatics cell manufacturing,. LED device manufacturing are classic examples. These are necessary and important from the perspectives of energy generation, security, independence, storage, etc.

While the semiconductor chips consist of transistors (PNP, or NPN) as the basic building blocks – the solar cell has a PN junction (converting light into electric current), as does the LED device (which converts current into light).

The renewable industry will help to grow this semiconductor manufacturing ecosystem, and is interdependent with the semiconductor chips manufacturing industry:

- The types of equipments used (CVD, PVD, Etch, etc) are similar. There could be a few minor changes depending on whether one is in the Crystalline-Silicon (c-Si), or the Thin-Film (TF), arena. (the TF line could be Amorphous-Silicon, organic, CdTe, CIGS, etc).
- The investments are much less (about 300 million dollars for a 100MW line) as compared to the semiconductor fabs (which run into 2.5-3.0 billion dollars)
- Since solar is clean energy, this could attract further investments in various forms.
- Given the varying oil prices and a finite supply of coal based reserves – solar is a very viable alternative. India needs to look at alternative renewable energy sources in a big way.
- LED devices are considered to be the future for low energy consumption light sources.
- There will be a growing demand for solar cells/modules/systems – both for export, and domestic consumption.
- The solar industry (along with the associated LED industries) will integrate into the NAPCC (National Action Plan on Climate Change) and the Solar Mission therein – as brought out by the Prime Minister of India in June 2008.

Advanced and highly technical manufacturing industries (automotive, pharmaceutical, semiconductor, etc) are becoming increasingly dependent on software to optimize their process, yield, etc.

India having established itself as a world power in software development and management, will be the ideal platform to add this very critical dimension in the manufacturing scenario.

Thus, the use of solar energy enhances the security of national energy supply because sunlight - as an indigenous resource—can be harvested for use in commercial and industrial heating and for electricity production, avoiding the need for fossil fuels in these applications. The advancement of solar energy provides India with an opportunity to lead the world to a clean energy future.

RECOMMENDATIONS

Manufacturing for India's Needs – While it is important to set up a semiconductor manufacturing base in India, multiple alternative routes can be considered:

- **Lower technology nodes to address the relevant industries which are growth sectors in India**
  - Solar
  - LED
  - Automotive
  - Healthcare
  - Industrial
  - Pharmaceutical
- **Alternative semiconductor industries to help build the manufacturing base**
  - Solar and LED
  - Similar processes and materials to the chip manufacturing industry
  - More elementary, less stringent constraints and conditions
  - Relevant to the country's energy needs
  - Naturally migrate to other key industries like LED manufacturing
  - Needs less capital to start
  - Can be scaled up depending on demand
- Enable the Manufacturing Ecosystem **– Set up facilities for all aspects of the value-chain**
  - Silicon feedstock manufacturing
  - Low cost solar cell and module manufacturing
  - Efficient storage batteries
  - LED device manufacturing
  - ATMP industry to cater to the above

  The holy grail is the reduction of “cost/transistor”, “cost/watt”, “cost/lumen” - and the ecosystem should help enable do that.
- Focus on R&D – in key areas like
  - New materials
  - Optimization of various process techniques
  - Disruptive energy storage systems and technologies
  - Yield and reliability
  - Standards and certifications

  are very important. Investments by, and collaboration between, government, academia, industry (including various research labs) are critical to maintain leadership in technology.
- Human Resources – The industry and government should help establish suitable educational programs in universities to help develop suitable human resources.
- Techno-Management aspects –
  - *On the technical front we need*
    - programs/courses for graduate and post-graduate levels in solar devices, manufacturing, systems, chemistry/physics, energy cells, storage, statistical methods and analysis, etc.
    - programs/courses for diploma, technician, operators levels in workshop practices, running and maintenance

of sophisticated machines and instruments, industrial automation, etc.

- On the management front

- specialized programs to understand the specific industry, key technical aspects, market and growth drivers, supply chain parameters, global trends, new business models relevant for India, etc.
- will require close synergy with the industry, and working hand in hand with them to evolve a program and strategy of relevance

SUMMARY

- Semiconductor manufacturing is important and critical for India's growth
- High end fabs, at the latest technology nodes
  - Need very intensive infrastructure (including power, water, chemicals, ...)
  - Are extremely expensive (including the latest, and very expensive equipments)
  - Need very high, and recurring, R&D expenses
  - Need sophisticated supply chain from Silicon to the packaging technology
  - Address niche segments like smart phones, tablets, etc
  - Do not address the “bottom of the pyramid” consumer base that is growing in India,
- Lower technology nodes which can cater to India's growth sectors are
  - Healthcare
  - Automotive
  - Industrial
  - Electronics
  - FMCG
  - Pharmaceutical

  and provide a business rationale
- The lower technology nodes are suitable for
  - Analog chips
  - Mixed-Signal chips
  - Solar cells
  - LED devices
  - Various chips and micro-controllers
  - MEMS devices

  which feed into the above growth industries
- The lower technology nodes are financially viable because
  - The equipments are less expensive
  - One can use depreciated, and refurbished, equipments from the other fabs
  - Requires comparatively little recurring R&D expenditure
  - Allow multiple fabs to be set up, thus generating more employment
- Alternative semiconductor industries like
  - Solar photo-voltaic cells
  - LED devices/chips

  provide yet another path for setting up semiconductor manufacturing in India
- Other ecosystem players like ATMP (Assembly, Test, Marking & Packaging) for semiconductor chips, EMS (Electronic Manufacturing Systems) are very important for the success of the semiconductor manufacturing industry. These are important to cater to end consumer and business segments, which are growing in India
- The large local demand, and domestic consumer base, from the above industries, needs setting up a complete semiconductor manufacturing ecosystem in India – thus minimizing the issues of supply chain and logistics

From Chairman's Desk

Clayton Christensen, who introduced the concept of Disruptive Innovation, more than a decade ago, has recently co-authored two Books dealing with Higher Education : Disrupting Class (2008/2011) and The Innovative University: Changing the DNA of Higher Education From the Inside Out (2011), and I will discuss the second Book in this Issue. Since the book's release, reviewers and educators have called the authors' ideas everything from "enlightening" to "toxic."

In sectors as divergent as photography, recorded music, book publishing, mobile phones, personal digital assistants, or postal services, disruption has taken a heavy toll of established industries. In the two Books, Christensen has focused on Higher Education through the lens of Disruption. The authors attribute the vulnerability of contemporary universities to what they refer to as its "DNA", which induces "conforming behaviors which are further reinforced by accreditation committees, media rankings, and journal editorships"." We also live at time when many of our heroes — Steve Jobs, Bill Gates, Richard Branson, Larry Ellison, Mark Zuckerberg , just to mention a few — are university drop-outs"; learning by doing is accorded more prominence than university degrees.

Most Educators do not believe that classroom-centric instruction will continue to dominate the world of higher-education as it has in the past. Revered Universities like Stanford and MIT offer world-class educational content for free to all takers. The "certificate" programs of these institutions could well come to represent an entirely new category in educational offerings which might someday soon rival the power of the traditional diploma.

The key concepts introduced in the Book include:

- "A disruptive innovation brings to market a product or service that isn't as good as the best traditional offerings, but is less expensive and easier to use.
- Online learning is a disruptive technology that is making colleges and universities reconsider their higher education models"

A disruptive technology, online learning, is invading higher education, allowing both for-profit and traditional not-for-profit institutions to rethink the entire traditional higher education model.

The DNA analogy is from the fact that "much as the identity of a living organism is reflected in its every cell, the identity of a university can be found in the structure of departments and in the relationships among faculty and administrators". "It is described in course catalogs, criteria for admitting students and promoting professors, and into strategies for raising funds".

Christensen and Eyring argue that "not all colleges can or should be everything to everyone and that most institutions today need to innovate to survive". "In addition to reducing its program offerings, the focused university will modularize its majors, allowing students to customize their education and graduate timely. The successful university will also embrace the opportunity to teach values, both formally and in faculty-student mentoring relationships."

The authors believe that online learning is crucial for the "Innovative University." "Undergraduate students who prepare for face-to-face classes via online lectures, problem sets and discussion boards can take Socratic discovery to levels like those of the best graduate business and law schools. This kind of hybrid learning holds the potential to create not only the equivalent of an Industrial Revolution in higher education, but also a learning renaissance. We can serve more students not just at lower cost but also at higher quality." The authors do not say that all classes should be online but that all colleges should try to incorporate online learning to lower costs and to reach more students.

Harry Lewis, former dean of Harvard College, was quoted on the book's website as saying "The Innovative University offers fascinating new perspectives on very old questions. What defines a university's identity? Are all universities cloned from the same ancestral stock? Are there still opportunities for diversity in American higher education, or is a single ideal to be approximated with greater or lesser fidelity?"

Christensen and Eyring have offered five suggestions for higher education innovation :

1. Become No.1 in the "ranking" of your own students, faculty, alumni and other direct supporters
2. Focus on what you do best
3. Embrace online learning technology
4. Grow the student body
5. Put personal values back into higher education

- Prof. R. Natarajan

Faculty Development Workshop on "Cloud ComputingPerspectives and Challenges"

Date: 8th February 2013

Venue: Srinivas Institute of Technology, Valachil, Mangalore

Cloud computing is rapidly evolving, with Individuals, companies and also Governments embracing this new technology. Industry experts believe that cloud computing holds tremendous promise with more and more service providers joining this bandwagon. There has been a persistent demand from our member Institutions to hold workshops on Cloud Computing. In deference their wishes this is the third in the series of workshops that BITES is organizing on Cloud Computing.

This workshop explored the fundamental concepts behind cloud computing and its evolution, how Providers and Consumers view cloud computing and how cloud is going to shape up in future including the challenges and research areas. The workshop traced the evolution of cloud computing as an extension of Grid Computing and Virtualization. The availability of cheap internet bandwidth coupled with economic considerations like minimal CAPEX, need to store very large amounts of data and Time to Market considerations resulted in cloud computing emerging as a viable alternative. The ability of Cloud computing to provide resources that can scale elastically with respect to demand while keeping QOS constant was emphasized. The three types of Services that cloud service providers offer, i.e. IaaS (Infrastructure as a service), PaaS (Platform as a service) and SaaS (Software as a Service) were compared and contrasted. Cloud market place is now well defined and diversified; the services offered by prominent cloud service providers like GooGle, Salesforce, Azure, Amazon, GoGrid etc. was illustrated with examples.

Mr.Chitta Prasad of TCS conducted the workshop which was attended by over 70 faculty members belonging to BITES Member Institutions.

Sahyadri is BITES New Institutional Member

On 22nd January, Sahyadri College of Engineering and Management, Mangalore (SCEM) joined the elite club of BITES institutional members. BITES extends a hearty welcome to SCEM on the occasion of becoming BITES institutional member and wishes good luck in all their future endeavours. We look forward keenly to network with SCEM in our activities.