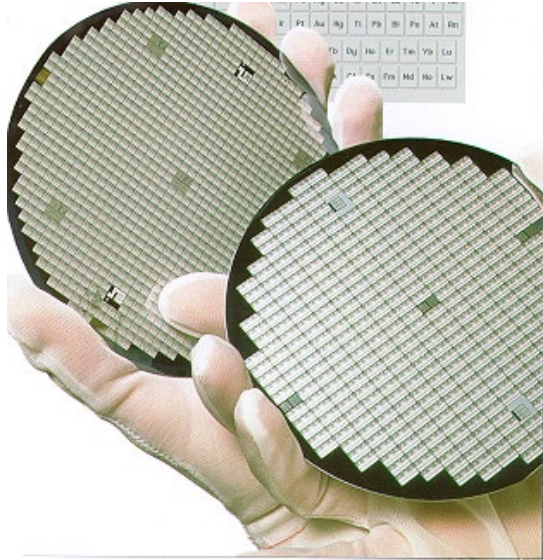


Wafer Fabrication Fundamentals (ET0902)



Module Aim

- Provide the student with knowledge and understanding of the wafer fabrication environment, facilities and processes for the production of semiconductor electronic devices, Integrated Circuits and other devices using wafer fabrication technology

Instructional hours

- Lecture with Tutorial: 2 hours
- Practical with Quiz: 2 hours

Assessment

- General Performance (CA1): 10%
- Online Formative Lab Quizzes (CA2): 15%
- Online Formative Tutorial (CA4): 15%
- Summative online Lab Quiz (CA5): 30%
- Summative online Assessment (CA9): 30%

Teaching Schedule

Refer to Bb

Reference Textbook

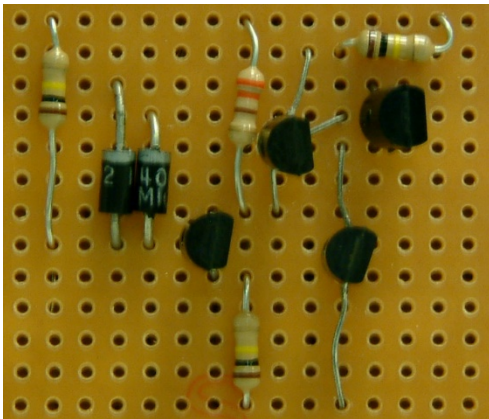
Jaeger, R. C., 2002. ***Introduction to Microelectronic Fabrication***. 2nd ed. Upper Saddle River, N.J. : Prentice Hall

The Electronic Manufacturing Industry

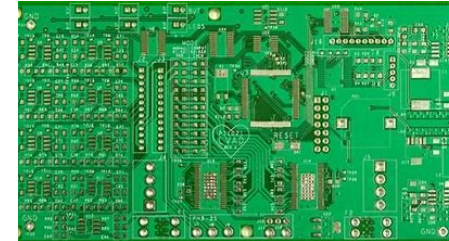
Commercial & Retail Electronics Appliances (What goes into them?)



Printed Circuit Board Assembly (What is required?)



Printed Circuit Board & Design



Integrated Circuit (IC) & Discrete Devices



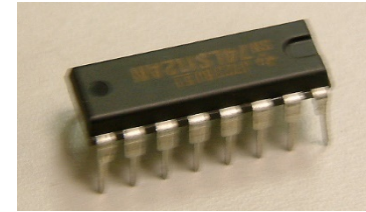
The Electronic Manufacturing Industry

Integrated Circuit (IC) Manufacturing (What goes into them?)

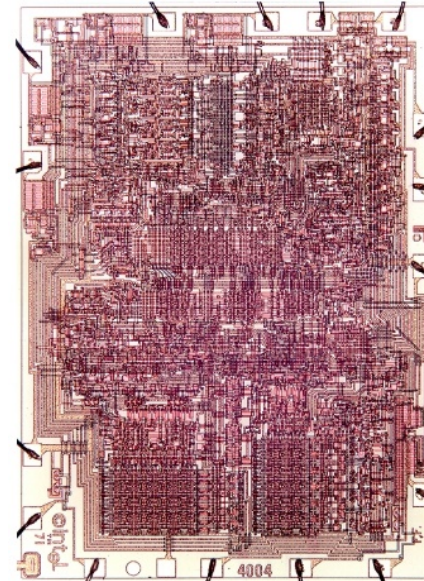
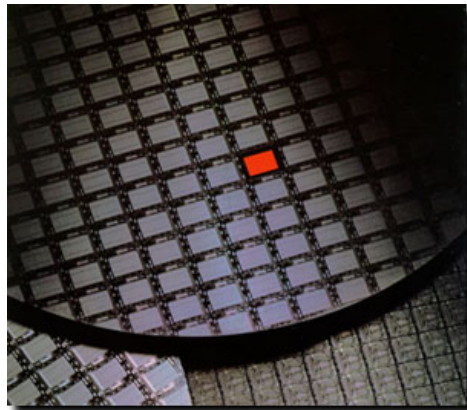
Back End



IC Chips/ Die

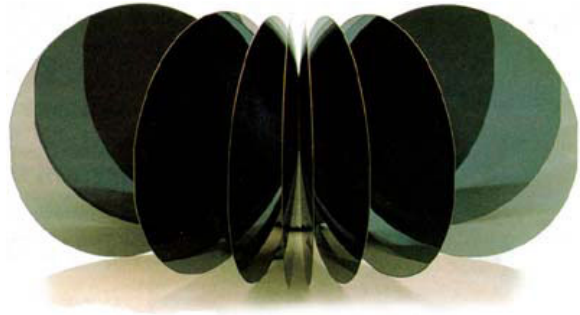


Wafer Fabrication

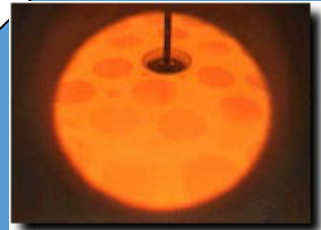


Front End

Different Processes of Wafer Fabrication Technology



Silicon Wafer



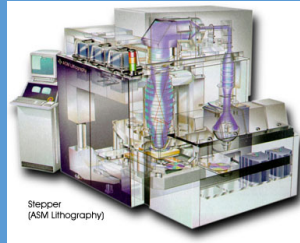
Epitaxial Reactor Interior
(Mitsubishi Materials Silicon)



Oxidation Furnace
(Silicon Valley Group - Thermco Systems)



Photoresist Application
(Orbital)



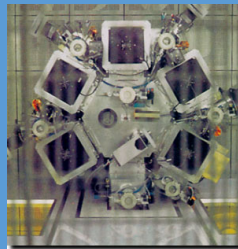
Stepper
(ASM Lithography)



Automated Acid Etch
(SEZ)

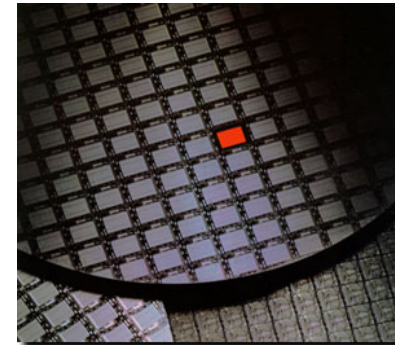


Ion Implanter
(Varian Associates)



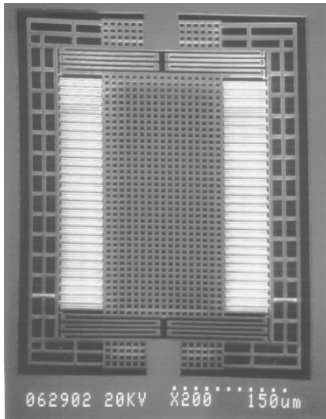
PVD Sputtering Tool
(Sputtered Films Corporation)

IC on the silicon wafer



Other Devices Produced by Wafer Fabrication

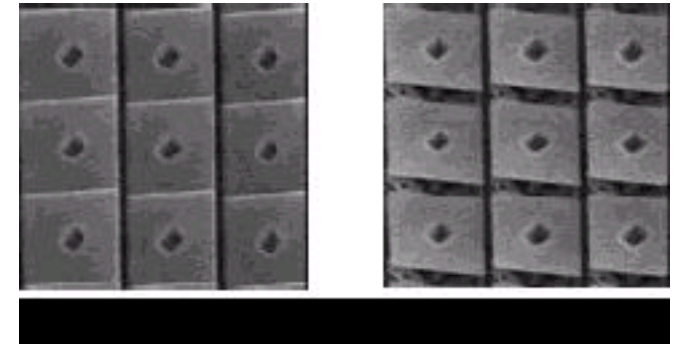
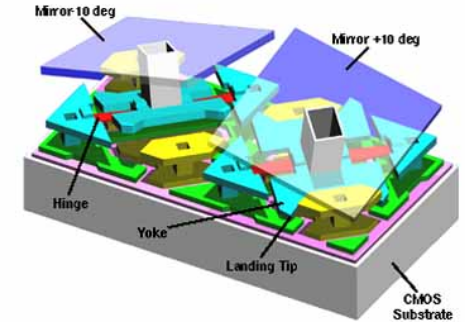
MEMS (Micro Electromechanical Systems) & Photonics



- Accelerometer
- 300x400um
- Found in cars
- Use to activate air-bags



Bio MEMS



- DLP
- Digital Light Processing by TI
- Used in projection displays

Wafer Fabrication

- Wafer fabrication is a high end technology that enable us to produce miniaturized components, devices and systems on semiconductor wafers.
- Its technology composed of many repeated sequential processes to complete the electronic Integrated Circuit (Analog, Digital, ASIC or Memory), photonic circuit or Micro Electromechanical Systems (MEMS).
- A Wafer Fab is the plant where the processes are accomplished.
- Vacuum Technology, Microcontamination and Electrostatic Discharge (ESD) control techniques, including Ultra Pure Water (UPW) Production are common facilities requirements of a Wafer Fab.
- A Foundry is a Wafer Fab where IC chips are fabricated for third party companies that sells the chips.

Wafer Fabrication in Singapore

- Semiconductor Electronics
 - IC Design: Infineon, Broadcom, NEC, Marvell, Future Techno, WinEDGE
 - Wafer Fabs: Globalfoundries, SSMC, UMCi, STMicroelectronics, Infineon, Micron— IDM company
 - Assembly & Test Companies: AMD, Liner Technology, Micron, STATS, UTAC, Matsushita-Denshi
- The industry started in Singapore in the 1960s. Today, there are 32 IC design centres, 14 wafer fabs and 18 IC assembly and test facilities. There are 4 wafer fab parks in Singapore, occupying a total of about 260 ha of land in Woodlands, Tampines, Pasir Ris and the North Coast area near Senoko.

Wafer Fabrication in Singapore

Payoff for S'pore is in high-end manufacturing

S'pore can't be everything to everyone; right choices and balance are vital

By Kenneth James

WHEN Deputy Prime Minister Lee Hsien Loong invited Johan van Splunter almost a year ago to chair a subcommittee that would re-examine Singapore's manufacturing sector, he gave the panel carte blanche.

"DPM Lee did not give us guidelines regarding (the report's) output," Mr Van Splunter recalls. "He said, 'Give us a fair view of what you believe is happening and what we should be doing as a country in order to be a thriving economy in the future. So you can tell us, stop manufacturing in Singapore. (Or) do a lot more. Or do totally different things in manufacturing.'"

That wasn't a responsibility to take lightly. But for the chairman and his team, it was a rare opportunity to help improve a working environment where they are all distinguished players.

As Philips' Asia-Pacific president and chairman, Mr Van Splunter looks after all of the European electronics giant's operations from China to India. Other subcommittee members represent major organisations like STMicroelectronics,

Shell Chemicals and Matsushita Electric. And for each, the commitment over the 10-month period would be significant. "Yes, it took a lot of time," Mr Van Splunter says with a slight smile. "I was not totally aware of the amount of work involved and the amount of data that we would have to make ourselves familiar with."

In seeking to cast the net wide, the panel set up working groups and roundtables, holding countless meetings that involved dozens of industry leaders.

And in the end, the conclusions and recommendations were relatively easy to make, because they were working from a strong base, the chairman notes. "A very important conclusion is that Singapore cannot be everything to everybody; it has to make choices. But Singapore in the past has been making choices, and the quality of the (policy-makers) has been such that the choices were correct ones, really ahead of their time."

That became clear when the subcommittee looked at manufacturing in terms of clusters of industries, as Mr Van Splunter explains: "You need to have the right balance. You need activities that have stability and continuity, and at the same time you need other clusters that may have ups and downs but have growth potential.

"I believe Singapore found the right balance, with the stability factor of the chemicals cluster, the Jurong Island sector; the high-tech growth potential of the semiconductor environment; and most significantly, biomedical sciences, which is up and coming. And (the fourth cluster) transport is the consequence of the success of the other clusters. Stability, growth and potential."

Services, he notes, supports the manufacturing process. "The more productive you are in your manufacturing processes, the more services you can have, and the more value you create. And that is why you need a very strong manufacturing sector. Yes, you could have only services which you offer other countries who do the manufacturing. But (the combination) is much stronger when you do the manufacturing yourself."

And he doesn't buy the argument about Singapore manufacturers pricing themselves out of the market. "First of all, it's a tremendous compliment to a country that it has become somewhat more expensive than in the past, because it shows that the country has created competencies and wealth. And that, of course, is reflected in the remuneration. The people of Singapore have upgraded themselves with higher skills through the education

system. Of course they will want to do more valuable work. So the question is not, What is expensive? The question is, How high is the productivity per employee? If they produce more than what they cost, then you are in good economic shape. And Singapore is in that situation.

"But it does mean Singapore is not able to do simple low-end manufacturing. For example, in the case of Philips, simple assembly of TV sets cannot be done in Singapore any more. But what you can do is manufacture the chips that go into these products, because that is where the intellectual value of the people can be used."

Mr Van Splunter points to the Philips Innovation Campus, a large building visible from his Toa Payoh office. "There are more than 1,000 people in that building," he says, "They create products for manufacturing in China, and the products go beyond the region."

"In China, we have more than 30 Philips facilities, accounting for more than 20 per cent of (Philips') global output. We create (those products) to a large extent in Singapore." Singapore also houses the global HQ for some product lines, like its DVD players, he notes.

And that is a demonstration of the value manufacturing concept the subcommittee is advocating for all manufacturers here.

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Manufacturers urged to undergo image makeover

Sector's poor perception partly why S'poreans shun these jobs

By David Boey

MANUFACTURERS have been urged to enliven their sector's dowdy image among job seekers to help overcome one of the hurdles that could crimp its growth — high dependence on foreign labour.

As things stand, some electronics multinationals have found it hard to hire local staff, partly because of the sector's poor image among Singaporeans, a subcommittee of the Economic Review Committee said yesterday.

Outlining the manufacturing subcommittee's view on the electronics cluster, semiconductor industry veteran Renato Sirtori said STMicroelectronics recently spent \$50,000 over 15 days to advertise several hundred jobs at a cleanroom in Ang Mo Kio — and just 19 Singaporeans were hired.

STMicro is Europe's biggest microchip maker.

He said that though several hundred people responded to the ads, only 84 said they were interested when told they would have to work in a cleanroom — an air-conditioned, enclosed space where operators must wear special suits to reduce the chances of particle contamination.

Of those keen on the job, STMicro hired 39 people — but only 19 of these reported for work 15 days later.

The company then went to Malaysia to look for workers and netted 350 applicants in a single weekend — 140 of whom were

given the jobs in Singapore.

"Sometimes there is no desire for Singaporean workers to take jobs in a cleanroom or to do shift work," Mr Sirtori lamented.

The manufacturing subcommittee says in its report that Singapore has the potential to develop into "a world-class electronics hub offering manufacturing solutions and value-added services across the entire value chain of activities".

To achieve this, the subcommittee has proposed that Singapore sharpen its competitive edge by strengthening dominant sectors like data storage and enhancing the "hubbing role" with Indonesia's Riau Islands. Other recommendations touch on the development of technology, markets and enterprise, with the last element tailored to "nurture the growth of start-up

companies". One example of how electronics firms can migrate to "high-end activities" is the Philips Innovation Campus in Toa Payoh, which hosted yesterday's ERC briefing. The Dutch electronics giant revamped factory space, formerly used to assemble television sets, to house its team of TV designers.

The subcommittee's report says the electronics cluster should aim to be the base of high-end manufacturing and headquarters functions.

"It should take advantage of the strategic location at the heart of the South-east Asian market, which we must not forget has half a billion people with purchasing power," Mr Sirtori noted.