## Integrated Circuits and Manufacturing

**1-24-2003**

## Opening Discussion

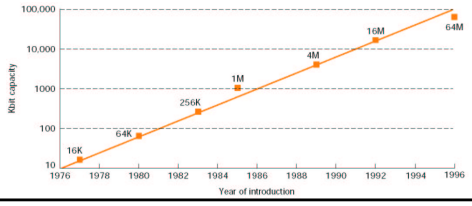
- What did we talk about last class?
- Do you have any questions about the reading? How much do you know about how chips are manufactured?
- Have you seen anything in the news?

## Integrated Circuits

- The advancement of computers has really been the result of advancement in the technology for building them. Probably the most significant advancement in this field is the integrated circuit.
- The earliest computers used vacuum tubes to do their calculations. These were replaced by transistors, but the IC is what has lead to vast improvements in our computational power.

## Power of Exponential Growth

- In computing problems we have things that scale as $O(2^n)$. When talking about hardware, we love $O(2^t)$ improvement.

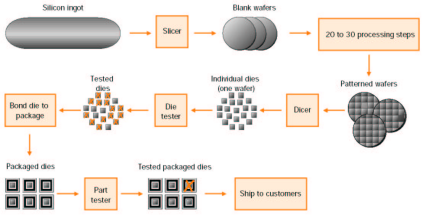



## Manufacturing of Chips

- To make a chip we basically want to be able to put a whole bunch of microscopic transistors on the surface of a piece of silicon. We also want tiny wires to connect them and thin insulator regions to prevent leakage of currents to areas where they shouldn't be.
- We want these things to be tiny. Current chip use a 130nm process and 90nm is in the works for this year.

## Getting the Silicon

- While silicon is very common on Earth, chips need pure silicon with perfect crystal structure. These are grown and sliced for making the chips.



## Fabrication

- The fun part of the previous diagram is in the "20-30 processing steps" box. This is when the circuits are laid out or etched into the silicon. We'll look a bit more in detail at the steps of this which your book doesn't really cover.
- Hopefully this will help you to understand some of the things you might read about advances in chip making.

## Deposition

- At various stages in the process of making a chip, the wafer is exposed to exposed to different vaporized or evaporated materials. These will either deposit on the top of the chip, or help implant impurities into the chip.
- This can be used to make insulating or conducting regions.

## Photoresist

- One of the real keys to the process is the use of a material called photoresist. The wafer can be covered in this material. When exposed to light it becomes weaker and can be removed.
- After a wafer is covered a mask is used to "cast a shadow" of the structure that needs to be make. Where light gets through, the photoresist and material under it can be etched.

## Diffraction Limit

- Roughly speaking, light can only be focussed down to sizes about equal to its wavelength. They can actually do a bit better than that, but how small you can focus light scales proportionally with the wavelength.
- If you can use shorter wavelengths you can make smaller features. So blue light is better than red, but ultraviolet is even better. Electrons could be better still.

## Etching

- The last main process is the etching. In this process, material is removed from the surface of the wafer.
- This is done by putting it into a plasma environment. The plasma basically blasts off the top layer if it isn't protected by strong photoresist.

## Minute Essay

- What questions do you have about the way that chips are made? If nothing else, hopefully this illuminated some of the complexities in making the chips you use. Do you have any interest in the physics of how these things work?
- I should get the description of assignment #1 up over the weekend.