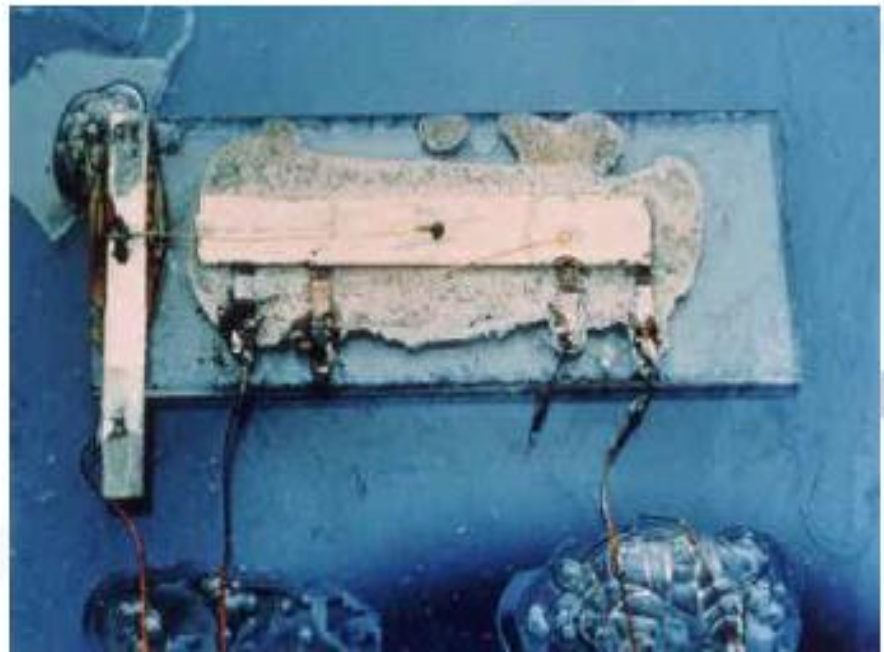


LECTURE-3

1958 - Integrated circuit invented

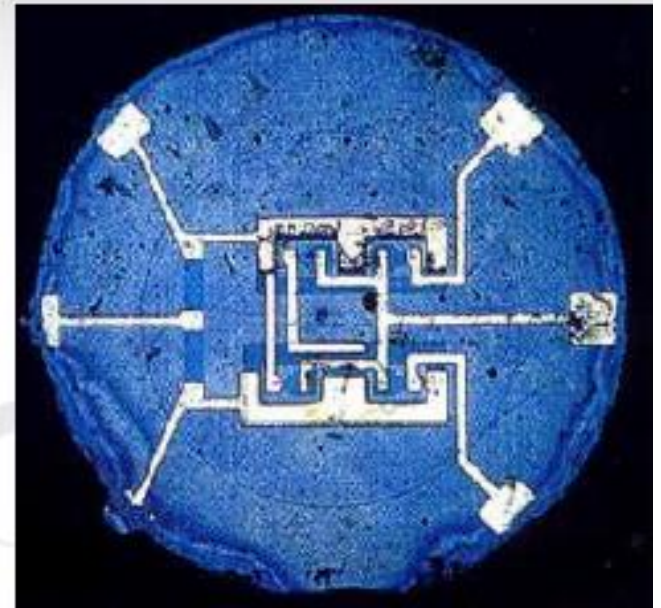
September 12th 1958 Jack Kilby at Texas instrument had built a simple oscillator IC with five integrated components (resistors, capacitors, distributed capacitors and transistors)

In 2000 the importance of the IC was recognized when Kilby shared the Nobel prize in physics with two others. Kilby was sited by the Nobel committee "*for his part in the invention of the integrated circuit*"



1959 - Planar technology invented

- Kilby's invention had a serious drawback, the individual circuit elements were connected together with gold wires making the circuit difficult to scale up to any complexity.
- The metal layer connected down to the junctions through the holes in the silicon dioxide and was then etched into a pattern to interconnect the circuit. Planar technology set the stage for complex integrated circuits and is the process used today.



Planar technology

IC Fabrication Technology: History (cont.)

- **1960 - Epitaxial deposition developed**
- Bell Labs developed the technique of Epitaxial Deposition whereby a single crystal layer of material is deposited on a crystalline substrate. Epitaxial deposition is widely used in bipolar and sub-micron CMOS fabrication.
- **1960 - First MOSFET fabricated**
- Kahng at Bell Labs fabricates the first MOSFET.
- **1961 - First commercial ICs**
- Fairchild and Texas Instruments both introduce commercial ICs.
- **1962 - Transistor-Transistor Logic invented**
- *1962 - Semiconductor industry surpasses \$1-billion in sales*
- **1963 - First MOS IC**

History

- 1964 – Bob Widlar designs the first op-amp: the 702.
 - Using only 9 transistors, it attains a gain of over 1000
 - Highly expensive: \$300 per op-amp
- 1965 – Bob Widlar designs the 709 op-amp which more closely resembles the current uA741
 - This op-amp achieves an open-loop gain of around 60,000.
 - The 709's largest flaw was its lack of short circuit protection.

History

- After Widlar left Fairchild, Dave Fullagar continued op-amp design and came up with the uA741 which is the most popular operational amplifier of all time.
 - This design's basic architecture is almost identical to Widlar's 309 op-amp with one major difference: the inclusion of a fixed internal compensation capacitor.
 - This capacitor allows the uA741 to be used without any additional, external circuitry, unlike its predecessors.
 - The other main difference is the addition of extra transistors for short circuit protection.
 - This op-amp has a gain of around 250,000