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A Brief Knowledge about MEMS Technology

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Abstract:
The definition of MEMS is Micro Electro Machine Systems. IC technology is the parent of MEMS technology. MEMS packaging and fabrications are more complex than IC packaging and fabrications. These systems are more small, high efficient and have better performance. MEMS have the benefits of miniaturization of systems, better performance, less cost, large reduction in power consumption and several advanced systems which can change the new emerging technological world. The present paper gives the knowledge about MEMS technology, its fabrication process, Basic silicon MEMS techniques and the future of MEMS technology.

***Key words**: Micromachining, Miniaturization, Sensors*

1. Introduction

The mechanical systems which have the size from 20 micro meters to 1 millimeter are all generally can be called as MEMS. Generally some components are essential to construct a mechanical system. Each individual component of mechanical system is generally smaller than the complete mechanical system. In the same way each individual component of a MEM is smaller than the complete MEM. These components are not only mechanical they are also electrical components. MEMS technology is mainly based on IC technology and most of components are taken from it. Using micro fabrication technology, MEMS integrates the mechanical systems electronics, sensors and actuators.

2. Applications of MEMS

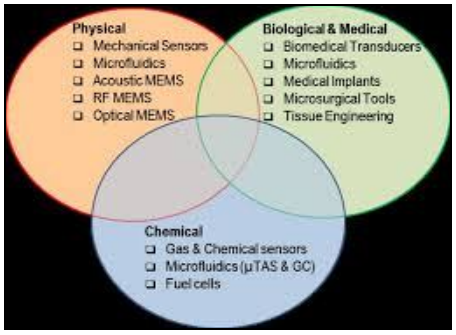

Figure 1

- Automotive: Internal navigation sensors, Air conditioning compressor sensor, Brake force sensors & suspension control accelerometers, Fuel level and vapour pressure sensors, Airbag sensors, tyres.

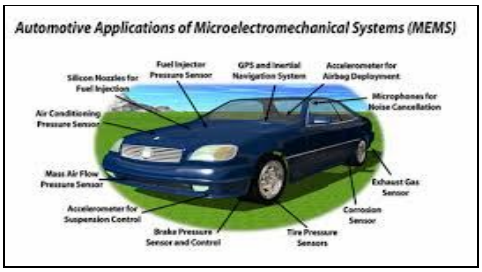

Figure 2

- Electronics: Disk drive heads, Inkjet printer heads, Projection screen televisions, Earthquake sensors, Avionics pressure sensors, Mass data storage systems
- Medical: Blood pressure sensors, Muscle stimulators & drug delivery systems, implanted pressure sensors, Prosthetics, Miniature analytical instruments, Pacemakers Communications: Fibre-optic network components, RF Relays, switches and filters, Projection displays in portable communications, Voltage controlled oscillators (VCOs), Splitters and couplers, Tunable lasers
- Defense: Munitions guidance, Surveillance, devices and instrumentation Arming systems, embedded sensors, Data storage, Aircraft control

The following are some other applications of MEMS devices. They are micro engines, ink-jet-printer cartridges, inertial sensors, RF-MEMS, micro actuators, micro transmissions, accelerometers, transducers, miniature robots, optical sensors, locks, fluid pumps, pressure sensors, micro mirrors, chemical and fluidic sensors, poly silicon resonator transducers, high aspect ratio electrostatic resonator, precision engineered gears, smart dust, electrostatic linear inch warm motor, piezoelectric shear actuated beam etc., .

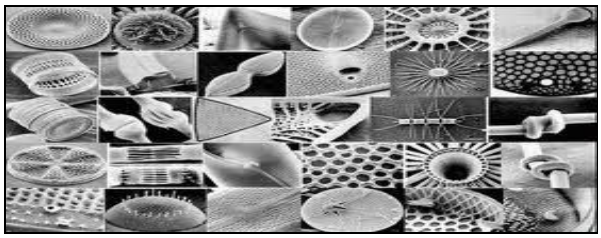

Figure 3: Various applications of MEMS

As decreasing the volume ratio of MEMS the surface area becomes large.

3. Working Method of MEMS

Usually MEMS consist of a central unit that contains microprocessor that processes data. Different kind of signals is taken by the sensors as input. The input may be information belongs to optical, magnetic thermal, mechanical, biological, and chemical signals. The actuators give the output in the form of mechanical action.

Three different kind materials are used to manufacture the MEMS. They are 1) Silicon, 2) Polymers and 3) Metals. In metals generally silver, gold, platinum, nickel, tungsten, aluminum and chromium are used to manufacture. Metals can be deposited by electroplating, sputtering processes and evaporation. The manufacturing process of MEMS consists of four steps.

They are 1) Design, 2) Fabrication 3) Packaging 4) Testing.

4. History

- 1958 Silicon strain gauges commercially available
- 1959 Richard Feynman invented an electrical motor smaller than $1/64^{th}$ of an inch.
- 1961 Silicon pressure sensor demonstrated
- 1970 Silicon accelerometer demonstrated
- 1979 Micro machined inkjet nozzle
- 1980 experiments in surface micro machined silicon.
- 1982 Disposable blood pressure transducer
- 1982 LIGA Process
- 1988 First MEMS conference
- 1990's Methods of micromachining aimed towards improving sensors.
- 1992 Multi-User MEMS Process (MUMPS)
- 1993 Surface micro machined accelerometer (Analog Devices, ADXL50)
- 1994 Deep Reactive Ion Etching
- 1995 BioMEMS rapidly develops
- 2000 MEMS optical-networking components become big business
- 2005 designers start using different Software to design MEMS

5. MEMS Fabrication Processes

The parent of MEMS technology is IC technology. So the process of MEMS technology is nearly same as IC fabrication technology. The following processes are the MEMS fabrication processes.

- Deposition processes: In this deposition processes the commonly used deposition processes are Electroplating, Physical vapor deposition (PVD), Chemical vapor deposition (CVD) and Sputter deposition.
- Photolithography: A photosensitive material is taken and exposed to radiation. Some selected area is covered before exposed to radiation. Then the material gets change in its physical properties, from unexposed to exposed regions. Then this exposed region can be removed and terminals will be arranged to the material.

1) Wet etching, 2) Dry etching, Anisotropic etching, Electrochemical etching (ECE),Reactive ion etching (RIE), Deep reactive ion etching (DRIE), Xenon difluoride etching.

6. Silicon MEMS Fabrication Techniques

These are three types.

- Bulk micro machining2) Surface micromachining3) High aspect ratio (HAR) micromachining

Figure 4

7. Future MEMS is NEMS

NEMS stands for Nano Electro Mechanical Systems. NEMS are smaller than MEMS in size. NEMS technology works in the scale of nanometer. It has the ability to measure small displacements and forces at molecular scale. It builds the machines with the weight of few attograms and with cross-section of about 10 nanometers. Researchers from IBM the first very large scale integration (VLSI) NEMS were introduced. Carbon nanotube nanomotor is one of the examples of NEMS device. Quantum mechanics also involves in this technology due to energy can dissipated by vibrations in such extremely small devices.

8. Conclusion

The present MEMS technology is younger than IC technology and it is older than NEMS technology. This kind of technology growth is inevitable to our society. Based on the above and recent changes in technology we can say that MEMS technology is the 21st century's one of the most important manufacturing technology. However there are some challenges are also there in the technology to obtain good benefits from this technology to the society. There are some requirements are still needed in reduction of cost, packaging & fabrication of MEMS. MEMS technology shows 20% annual growth rate per year presently.

9. Acknowledgments

With deep gratitude, respect and love to Supreme parabrahman and to all my masters and teachers and to my mother and father.

10. References

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