

MICRO-ELECTRO- MECHANICAL SYSTEMS

1.INTRODUCTION

- MEMS or Micro-Electro Mechanical System is a technique of combining Electrical and Mechanical components together on a chip, to produce a system of miniature dimensions.



Mechanical

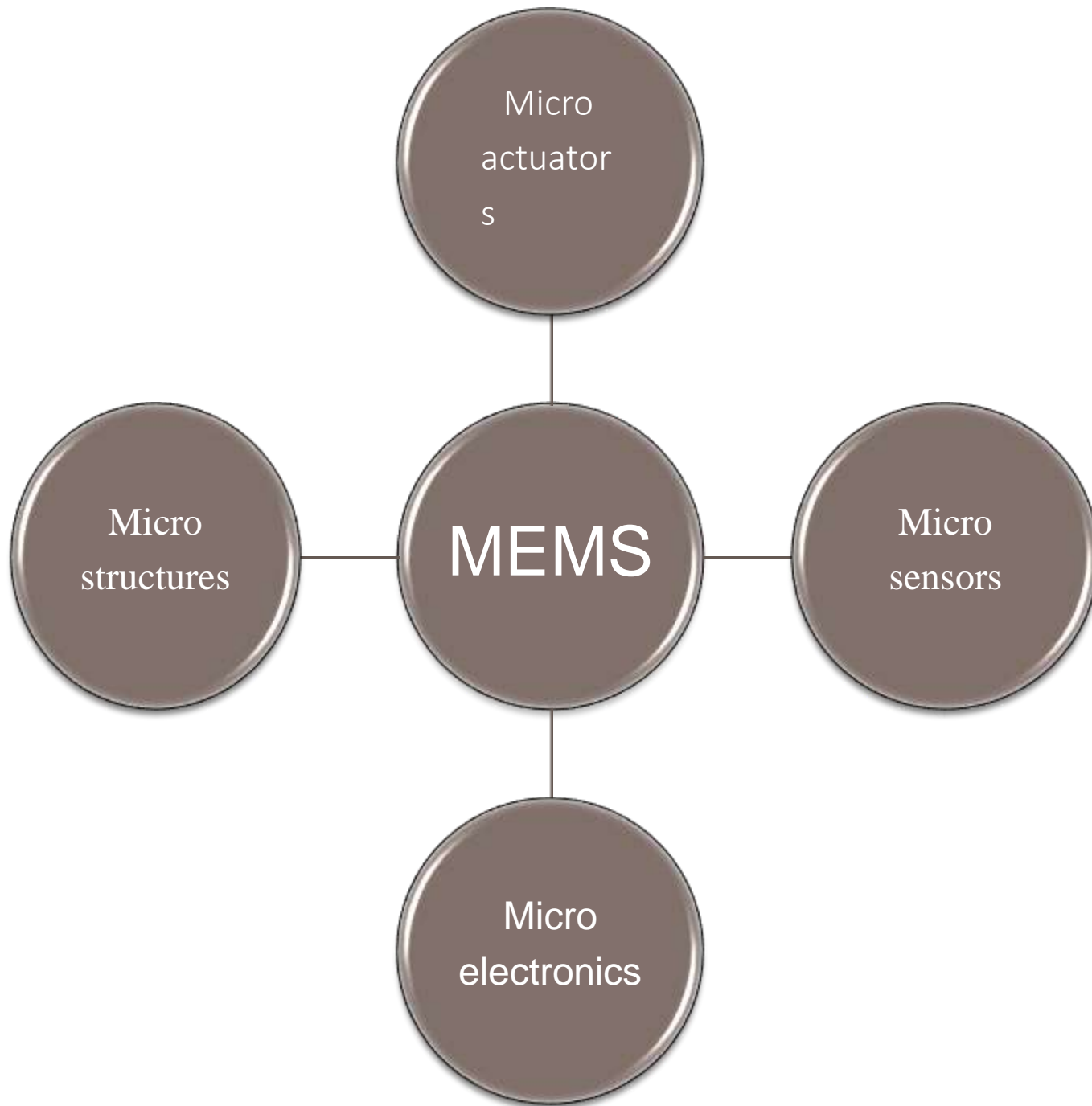


Electrical

- Integration of a number of micro-components on a single chip which allows the micro system to both sense and control the environment.

- Made up of components between 1 to 100 micrometers in size
- Devices generally range in size from 20 micrometers to a millimeter.





COMPARISON: IC'S VS. MEMS

MEMS

- 3D complex structures
- Doesn't have any basic building block
- May have moving parts
- May have interface with external media
- Functions include Biological, Chemical, Optical
-

IC

- 2D structures
- Transistor is basic building block
- No moving parts
- Totally isolated with media
- Only Electrical
-

WHAT IS A SENSOR?

- device used to measure a physical quantity (such as temperature) and convert it into an electronic signal of some kind (e.g. a voltage), without modifying the environment.

- **What can be sensed?**

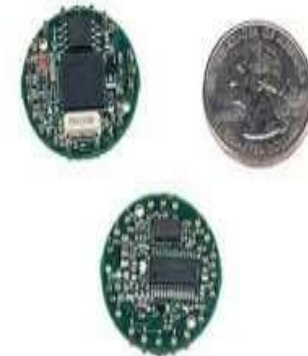
Almost Everything!!!

Commonly sensed parameters are:

- Pressure
- Temperature
- Flow rate
- Radiation
- Chemicals
- Pathogens

BUT WHY MEMS FOR SENSORS?

- smaller in size
- have lower power consumption
- more sensitive to input variations
- cheaper due to mass production
- less invasive than larger devices



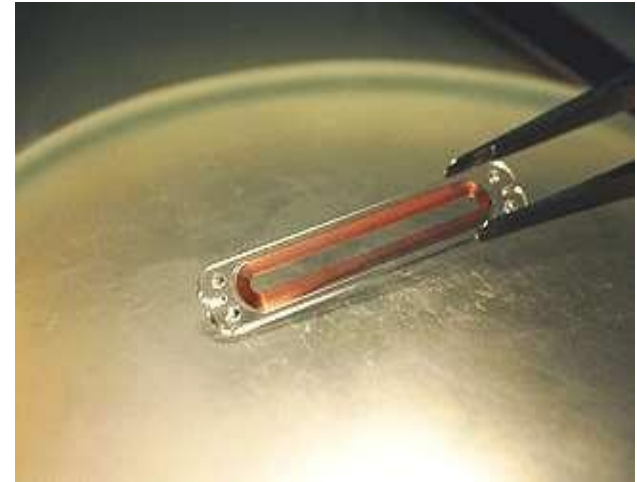
2. APPLICATIONS

- In medicine

MEMS flexibility surgery.

A MEMS is a device that can be implanted in the human body.

surgical tools provide the and accuracy to perform



- **Biomems**

Bio-mems are used to refer to the science and technology of operating at the micro scale for biological and biomedical applications.



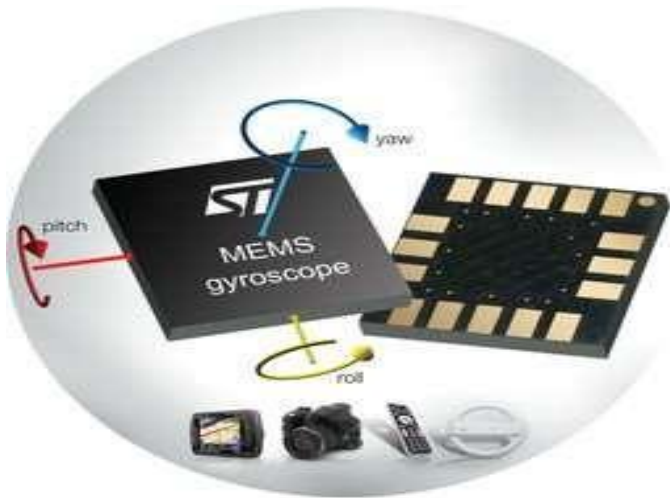
- In automobiles :

Heavy use of mems is found in air rollover detection, automatic door locks etc.



- As gyroscope:

Inexpensive vibrating structure gyroscopes manufactured with technology have become available. These are packaged similarly to other integrated circuits and may provide either analog or digital outputs.



- In microphones:

The mems microphone also called as microphone Chip is widely used in the present day communication world.







- In military :



Micro-electro mechanical system (MEMS technology help projectiles to reach their targets accurately.

3. ADVANTAGES AND DISADVANTAGES

-  Minimize energy and materials.
-  Improved reproducibility.
-  Improved accuracy and reliability.
-  Increased stability and sensitivity.
- Farm establishment requires huge investments.
- Micro-components are costly compared to macro components.
- Design includes very much complex procedures

4 DESIGN TOOLS :CAD

- In MEMS technology, CAD is defined as a tightly organized set of cooperating computer programs that enable the simulation of manufacturing processes, device operation and packaged Microsystems behavior in a continuous sequence, by a Microsystems engineer.

COMMERCIALY AVAILABLE SOFTWARE



<http://www.memcad.com>



<http://www.intellisense.com>



<http://www.tanner.com>



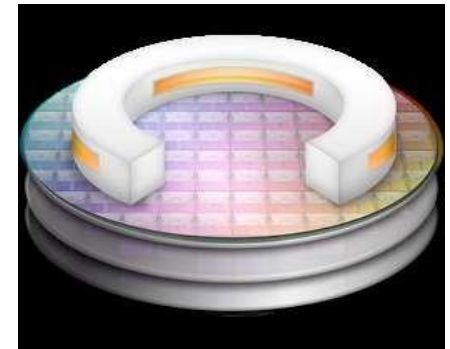
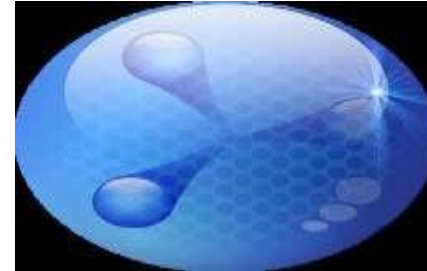
<http://www.memscap.com>



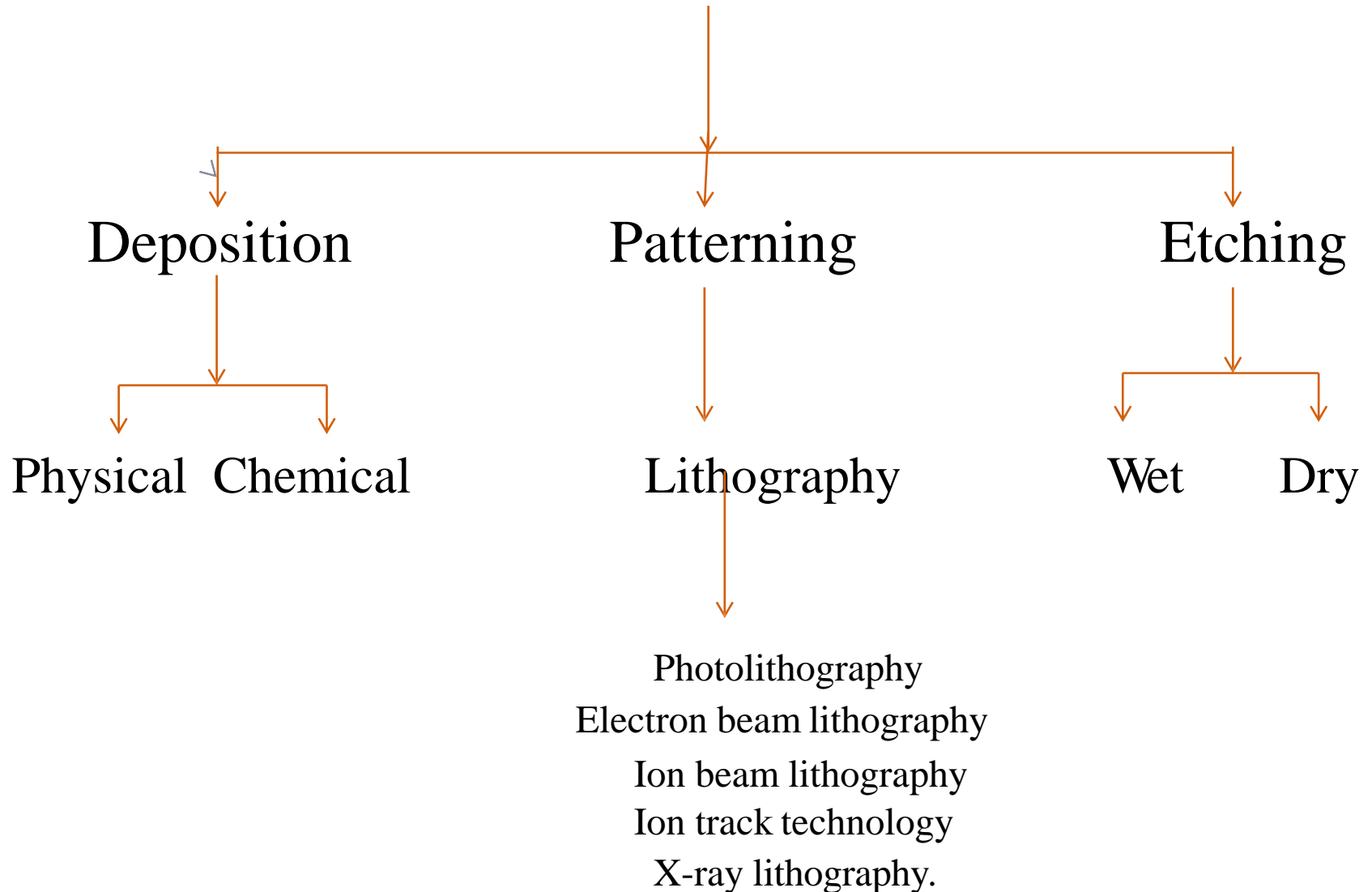
<http://www.ise.com>

EXAMPLE: INTELLISUITE ADVANTAGES

- Design for manufacturability
 - Fabrication database
 - Thin-film materials engineering
 - Virtual prototyping
- Ease of use
 - Consistent user interface
 - Communication with existing tools
- Accuracy
 - MEMS-specific meshing and analysis engines
 - In-house code development
 - Validated by in-house MEMS designers



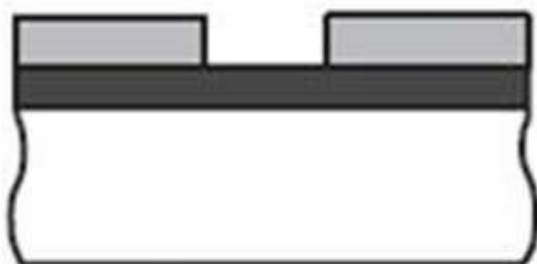
5. FABRICATION PROCESS





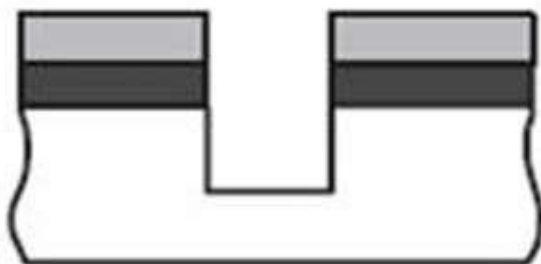
Deposition

- Epitaxy
- Oxidation
- Sputtering
- Evaporation
- CVD/LPCVD/PECVD
- Spin-on method
- Sol-gel
- Anodic bonding
- Silicon fusion bonding



Patterning

- Optical lithography
- Double-sided lithography



Etching

- Wet isotropic
- Wet anisotropic
- Plasma
- RIE
- DRIE



DEPOSITION

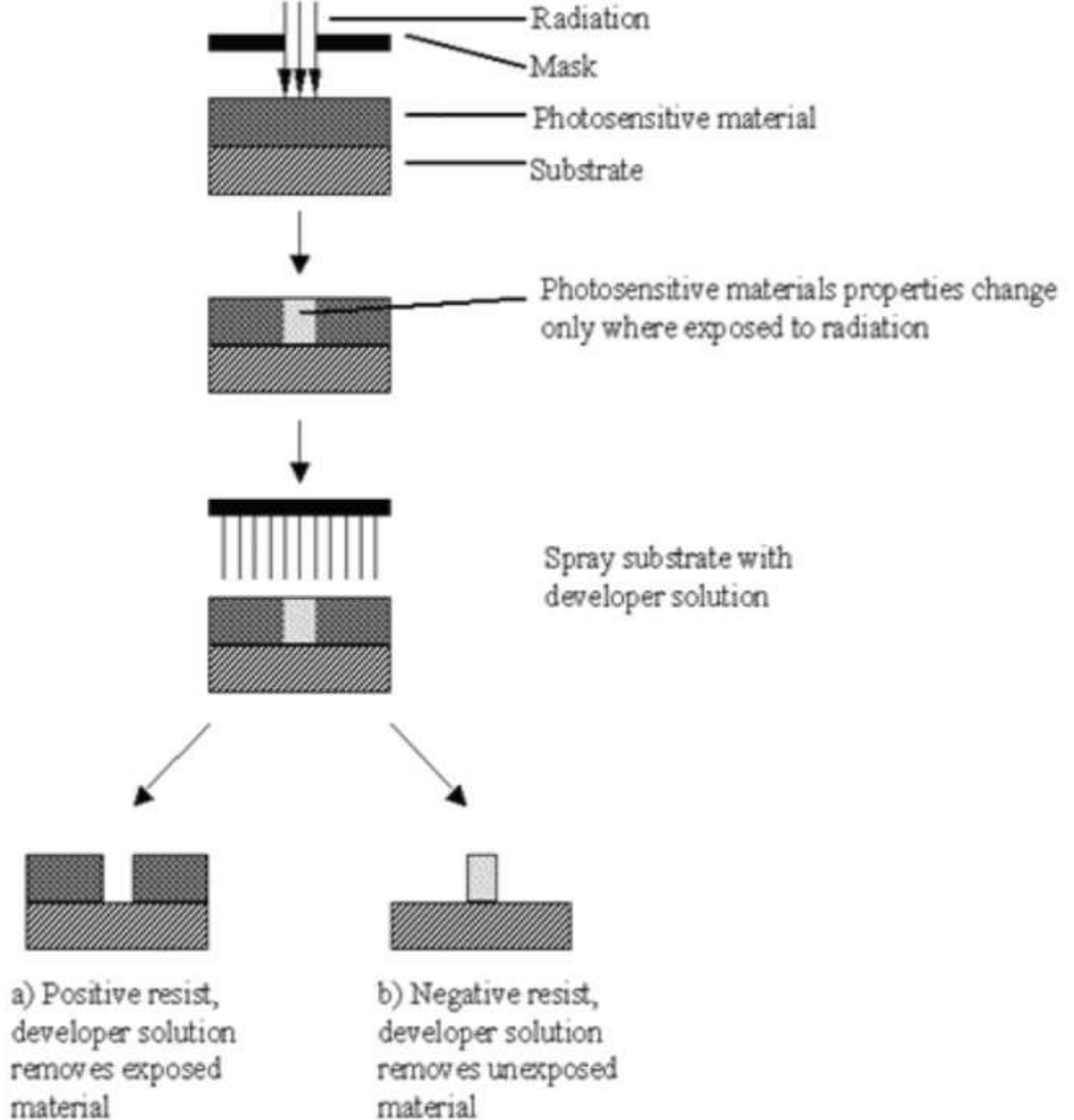
MEMS deposition technology can be classified in two groups:

1. Depositions that happen because of a **chemical reaction**:
 - **Chemical Vapour Deposition (CVD)**
 - **Electro deposition**
 - **Epitaxy**
 - **Thermal oxidation**
2. Depositions that happen because of a **physical reaction**:
 - **Physical Vapour Deposition (PVD)**
 - **Casting**

PATTERNING

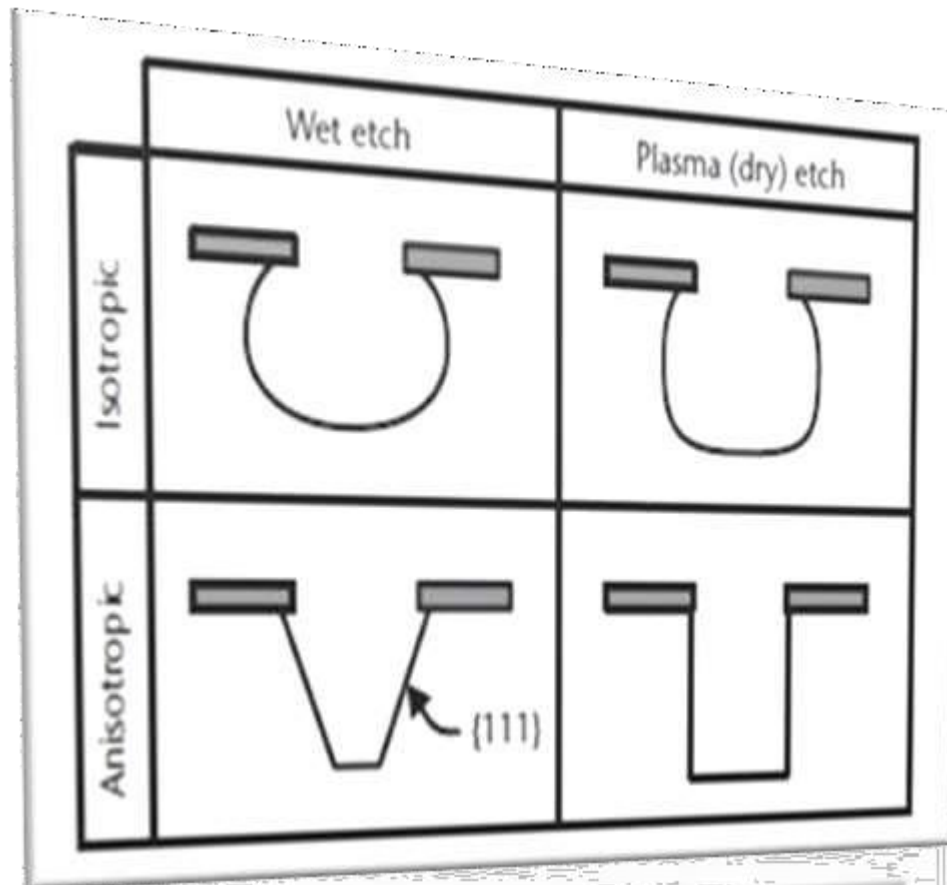
- Patterning of MEMS is the transfer of a pattern into a material.
- Lithography is a widely used process
- Examples of lithography are– Photolithography, Electron beam lithography, Ion beam lithography, Ion track technology, X-ray lithography.

Lithography



ETCHING

- Etching is the process of using strong acid to cut the unprotected parts of a metal surface to create a design in.
- There are two classes of etching processes:
 - Wet Etching
 - Dry Etching.

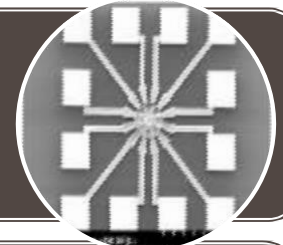


6. MANUFACTURING TECHNOLOGIES

Bulk Micromachining



Surface Micromachining



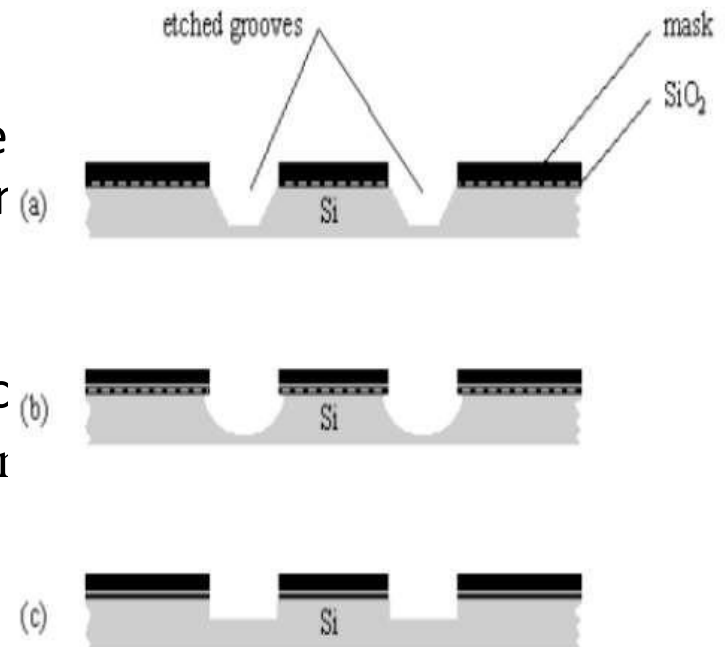
High Aspect Ratio (HAR) Silicon Micromachining



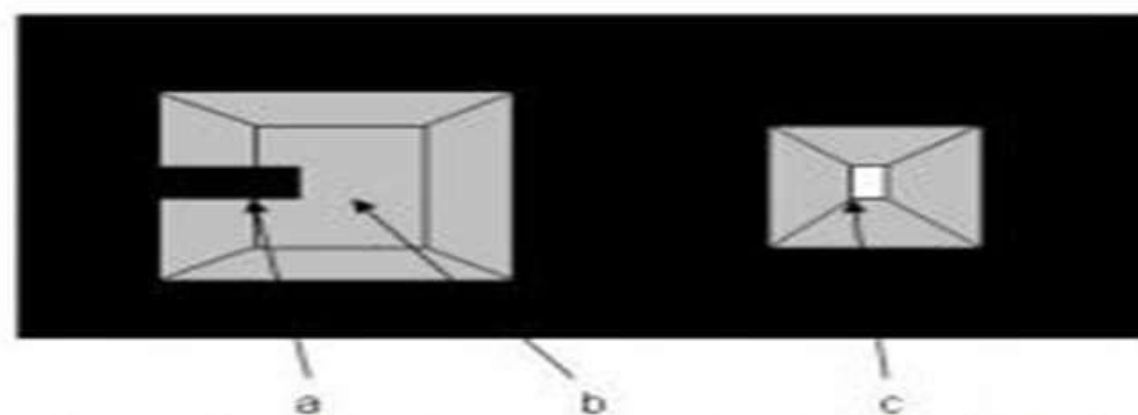
BULK MICROMACHINING

➤ This technique involves the selective material in order to realize miniaturized r

➤ A widely used bulk micromachining tec wet etching, which involves the in solution of reactive chemical that will substrate at very high rates.



Etched grooves using
(a) Anisotropic etchants,
(b) Isotropic etchants,
(c) Reactive Ion Etching



Top view of resulting structure:
 a: cantilever,
 b: Cavity,
 c: Wafer through hole

Figure 33 Basic process flow Bulk Micromachining process

SURFACE MICROMACHINING

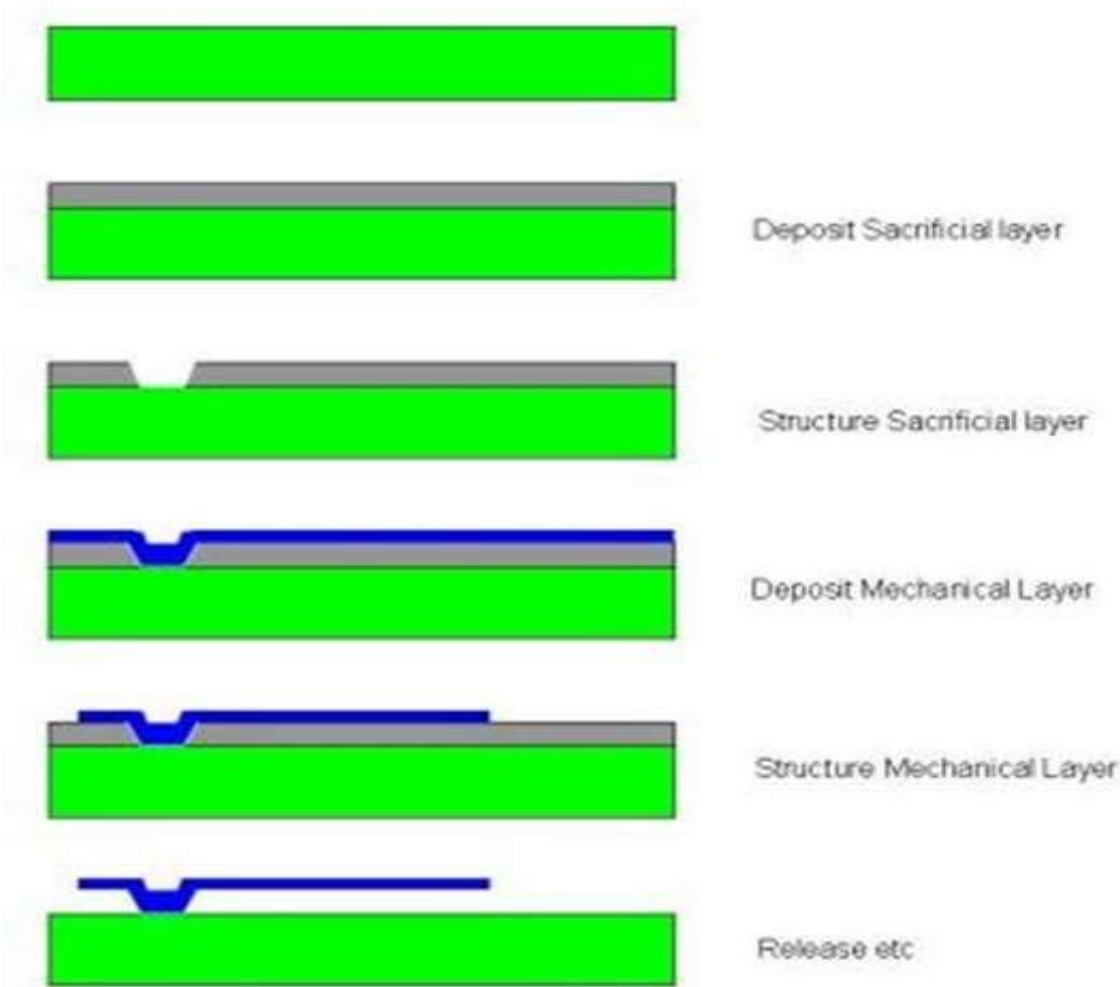
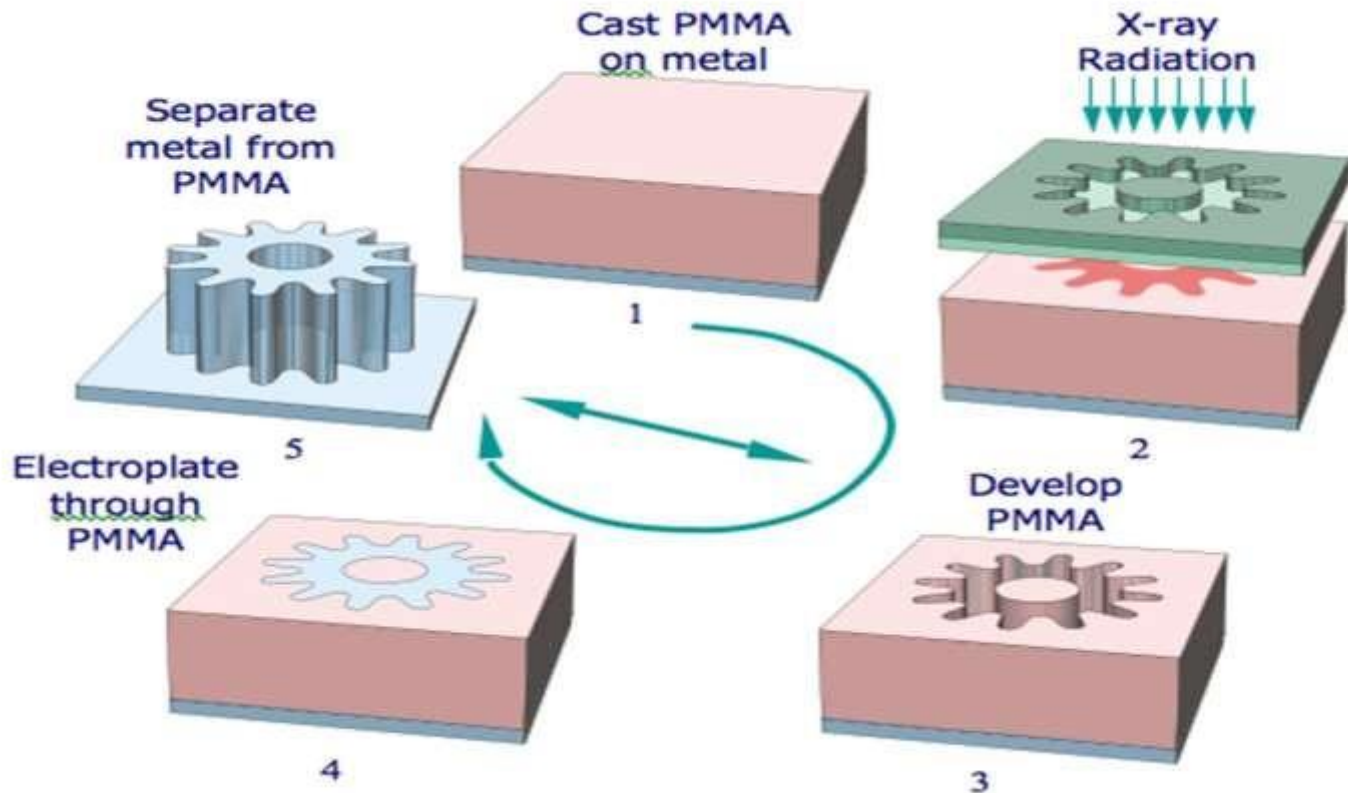


Figure 32 Basic process flow surface micromachining process

LIGA PROCESS

- LIGA is a German acronym standing for lithography, galvanoformung (plating) and abformung (molding).
- Polymethyl methacrylate (PMMA) is applied as photoresist to the substrate by a glue-down process.



8. CONCLUSION

- MEMS promises to be an effective technique of producing sensors of high quality, at lower costs.
- Thus we can conclude that the MEMS can create a proactive computing world, connected computing nodes automatically, acquire and act on real-time data about a physical environment, helping to improve lives, promoting a better understanding of the world and enabling people to become more productive.

THANK YOU