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Review Article

LEARN MORE ABOUT MICRO ELECTRO MECHANICAL SYSTEM

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ABSTRACT
Micro electro mechanical systems (MEMS) has been referred to as micro system technology of combining miniaturized mechanical elements, sensors, actuators and electronics. Its main applications include accelerometers, miniature robots, microengines, inertial sensors, micro- mirrors, optical scanners, transducers, pressure sensors and flow sensors. In present paper salient features and materials used for manufacturing of MEMS have been presented. Over and above, basic processes of fabrication and applications of MEMS have been highlighted in brief.

Keywords: *Micro Electro Mechanical Systems, Basic Process and Applications of MEMS.*

INTRODUCTION
MEMS technology is a distinctive class from the theoretical vision of molecular nanotechnology and molecular electronics (Core *et al.,* 1993; Don *et al.,* 2001; Fan *et al.,* 1988; French and Saroz 1998; Howe and Muller, 1986; Sharma, 2006; Sharma and Ojha, 2012). MEMS generally consist of a central unit, microprocessor, several components and functional elements like sensors, actuators and microelectronics. Microelectronics integrated circuits can be thought of as the "brains" of a system and MEMS enhances decision making capability with "eyes" and "arms" to allow microsystems to sense and control the environment (Core *et al.,* 1993; Don *et al.,* 2001; Fan *et al.,* 1988; French and Saroz 1998; Howe and Muller, 1986; Sharma, 2006; Sharma and Ojha, 2012). Sensors gather information from the environment through measuring mechanical, thermal, biological, chemical, optical, and magnetic phenomena (Core *et al.,* 1993; Don *et al.,* 2001; Fan *et al.,* 1988; French and Saroz 1998; Howe and Muller, 1986; Sharma, 2006; Sharma and Ojha, 2012). The electronics process the information derived from the sensors, through some decision making capability, direct the actuators to respond by moving, positioning, regulating for desired output. MEMS has also been referred as micro system technology. It has been recognized as one of the most existing technologies. It is an enabling technology allowing the development of smart products, enhancing the computational ability of microelectronics with the perception and central capabilities of microsensors and microactuators and expanding the space of possible designs and applications (Core *et al.,* 1993; Don *et al.,* 2001; Fan *et al.,* 1988; French and Saroz 1998; Howe and Muller, 1986; Sharma, 2006; Sharma and Ojha, 2012). The term used to define MEMS varies in different parts of the world. In the United States it is called micro electro mechanical system, while in Japan it is called micro machined devices and in Europe it is called micro systems technology. Applications of MEMS include inkjet printer cartridges, accelerometers, miniature robots, microengines, locks, inertial sensors, micro- mirrors, optical scanners, fluid pumps, transducers, pressure sensors and flow sensors (Core *et al.,* 1993; Don *et al.,* 2001; Fan *et al.,* 1988; French and Saroz 1998; Howe and Muller, 1986; Sharma, 2006; Sharma and Ojha, 2012). Keeping above in view the salient features and significance of MEMS have been discussed in this paper. Over and above, basic processes of fabrication and applications of MEMS have been highlighted in brief.

Basic Processes of MEMS
Basic process of MEMS involves three steps viz. deposition process, patterning and etching (Core *et al.,* 1993; Don *et al.,* 2001; Fan *et al.,* 1988; French and Saroz 1998; Howe and Muller, 1986; Sharma, 2006; Sharma and Ojha, 2012). A brief discussion of each step is given below:

Deposition Process
One of the basic building blocks in MEMS processing is the ability to deposit thin films of material with a thickness anywhere between a few nanometers to about 100 micrometers. Accordingly deposition process

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Core *et al.,* (1993); Don *et al.,* (2001); Fan *et al.,* (1988); French and Saroz (1998); Howe and Muller, (1986); Sharma, (2006); Sharma and Ojha, (2012) has been classified into two groups viz. physical deposition and chemical deposition. In physical deposition, physical reaction is responsible for the deposition which involves physical vapor deposition i.e. evaporation, sputtering and casting where as in chemical deposition, chemical reaction is responsible for the deposition which involves chemical vapor deposition (CVD), plasma enhanced CVD and thermal oxidation.

Patterning

Patterning in MEMS is the transfer of a pattern into a material lithography (Core *et al.,* 1993; Don *et al.,* 2001; Fan *et al.,* 1988; French and Saroz 1998; Howe and Muller, 1986; Sharma, 2006; Sharma and Ojha, 2012). In context of MEMS, it is done by selective exposure to a radiation source such as light. The properties of exposed and unexposed regions differ. This exposed region can then be removed providing a mask for the underlying substrate.

Etching Process

In order to form a functional structure of MEMS on a substrate, it is necessary to etch the thin films and the substrate itself. In general, there have been two basic categories of etching process viz. wet etching and dry etching (Core *et al.,* 1993; Don *et al.,* 2001; Fan *et al.,* 1988; French and Saroz 1998; Howe and Muller, 1986; Sharma, 2006; Sharma and Ojha, 2012). In wet etching the material is dissolved in a chemical solution followed by its selective removal of material by dipping a substrate into the solution. The chemical nature of the etching process provides a good selectivity where as in dry etching the material is sputtered or dissolved using reactive ions or a vapor phase etchant.

MATERIALS AND METHODS

Materials Used for MEMS Manufacturing

A number of materials (Core *et al.,* 1993; Don *et al.,* 2001; Fan *et al.,* 1988; French and Saroz 1998; Howe and Muller, 1986; Sharma, 2006; Sharma and Ojha, 2012) depending upon the nature of target device have been used for MEMS manufacturing. Silicon is the material used to make most integrated circuits in the modern world because of its important advantages engendered through its material properties. The basic techniques for producing all silicon based MEMS devices are deposition of material layers, patterning of these layers by lithography and then etching to produce the required shapes. MEMS devices can be made from polymers. Metals such as gold, nickel, aluminium, copper, chromium, titanium, tungsten, platinum and silver have also been used generally to create MEMS devices/elements (Core *et al.,* 1993; Don *et al.,* 2001; Fan *et al.,* 1988; French and Saroz 1998; Howe and Muller, 1986; Sharma, 2006; Sharma and Ojha, 2012).

Characteristic Features of MEMS Manufacturing Technology

There have been three characteristic features of MEMS manufacturing technologies viz. miniaturization, multiplicity and microelectronics (Core *et al.,* 1993; Don *et al.,* 2001; Fan *et al.,* 1988; French and Saroz 1998; Howe and Muller, 1986; Sharma, 2006; Sharma and Ojha, 2012). Miniaturization enables the production of compact, quick-response devices. Multiplicity refers to the batch fabrication. Microelectronics provides the intelligence to MEMS and allows the monolithic merger of sensors, actuators and logic to build closed loop feedback components and systems. Including these features, there are several different broad categories of MEMS technology viz. IC fabrication, Bulk micromachining & wafer bonding, surface micromachining, micromolding, high aspect ratio silicon micromachining. A brief discussion of each category is given below:

Applications of MEMS

MEMS pressure micro-sensors can be used to sense the absolute air pressure within the intake manifold of an automobile engine, so that the amount of fuel required for each engine cylinder can be computed. Conventional accelerometers have been replaced by the MEMS accelerometers for crash air bag deployment system in automobile. They have also been used in electronics devices such as game controllers, personal media players/phones, digital cameras and personal computers. MEMS Inertial sensors have been used to provide the power and size requirements for portable applications. They are also used as air-bag-deployment sensors in automobiles and as tilt or shock sensors. MEMS micro-engines can be used to drive the wheels of micro-combination locks. They can also be used in combination with a micro-transmission to drive a pop-up mirror out of a plane. In science and engineering new discoveries have been made using MEMS technology. Some of them are polymers chain reaction microsystems for amplification and identification of DNA, micro-machined scanning tunneling microscope, biochips for finding the hazardous chemicals and biological agents. MEMS technology can also be used for integration of electrical components such as inductors and tunable capacitors leading to reduction in power consumption cost and enhancement in the performance of communication circuits (Core *et al.*, 1993; Don *et al.*, 2001; Fan *et al.*, 1988; French and Saroz 1998; Howe and Muller, 1986; Sharma, 2006; Sharma and Ojha, 2012).

CONCLUSION

It may be concluded that MEMS technology has been recognized as one of the most promising technologies for its potential in making smaller, lighter and more functional electro-mechanical devices at lower costs with extraordinary levels of functionality, reliability, and sophistication. Its impact has been seen in many Hi-tech industries, such as data storage industry, information communication industry, bio-engineering industry and automobile industry. It is believed now that MEMS has the potential to renovate our day to day live to great extent (Core *et al.*, 1993; Don *et al.*, 2001; Fan *et al.*, 1988; French and Saroz 1998; Howe and Muller, 1986; Sharma, 2006; Sharma and Ojha, 2012).

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