MEMS and NEMS

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Group #
MEMS

- Microelectromechanical systems (MEMS) is the integration of microelectronic circuits on single chip which allows the microsystems to sense and control certain parameters [1].
- The components of MEMS are microsensors, microactuator, microelectronics and microstructures [2].
  - Microsensors and microactuators are the most remarkable components of MEMS and are consider transducers.
- MEMS is a technology expected to keep improving and also increase the use of nanotechnology as well as nanotechnology will increase the performance of MEMS [3].
NEMS

- Nanoelectromechanical system (NEMS) integrate nanoscale mechanical and electrical components into a single chip[4].
- In the nano scale, it is possible to obtain high frequencies while conserving the mechanical responsivity [5].
  - NEMS can enhance the capability of certain devices that required sensitive measurements [4].
  - Researchers have developed NEMS sensors using nanocantilevers, and NEMS resonator.
Application-Specific Integrated Circuit (ASIC)

- Temperatures that the following based semiconductors can withstand [6]:
  - Silicon up to 125 °C.
  - GaAs up to 350 °C
  - SiC up to 650 °C.
  - Diamond up to 1000 °C.
  - device that operates in oil wells can withstand 200°C.
Application-Specific Integrated Circuit (ASIC)

❖ Low Noise Design
  ➢ determines the accuracy weak signal been process without distortion [6].
  ➢ Research
    ■ development of low noise amplifiers for CMOS technologies.

❖ Low Power Design
  ➢ Its goal is to decrease power dissipation [6]
  ➢ The CMOS processes pushes the analog circuits to operate less than 3.3 V.
  ➢ Research
    ■ towards developing new methodologies and analog building blocks to operate at low voltage.
Research on MEMS and NEMS

❖ Micro-mirrors [7]
  ➢ Scanning micro-mirror
  ➢ 3-D micro-mirror for biomedical applications

❖ Sensors
  ➢ Accelerometer and interface ASIC
  ➢ Microphone
  ➢ CMOS integrated pressure sensor

❖ Switches
  ➢ Magnetic switches
  ➢ RF switches (capacitive/ metal-contact)
Research on MEMS and NEMS

- Resonators and filters
  - Vacuum packaged resonator
  - Piezoelectric resonator and filter
- Energy Harvester
  - Thermoelectric energy harvester
- CMUT Transducers
- Micro-Fluidics
  - Inkjet print-head
  - Micro PCR, DNA/RNA extractors
Getting an Idea of Size and Scale

- The components used to compose MEMS are usually between 1 and 100 micrometer.

- The total size of the MEMS is often between 20 micrometers up to about 1 mm.
Construction of MEMS

- Silicon is the most common material used in integrated circuits.
- Although, other materials can be used such as polymers, ceramics, or metals.
- The fundamental steps of the creation process include: Deposition, patterning, and etching.
NEMS Comparing with MEMS

• Developing a MEMS device has previously been seen as two separate systems. Where one system controls the computations and the other responds accordingly.

• It is apparent that as technology increases, the size of electronics usually decreases.

• NEMS introduce a way of integrating the two systems of MEMS into a single silicon chip.
A major focus of nanotechnology involves passing electrons through nano semiconductors in order to emit light.

With Baolab’s fabrication of NEMS, we will see multiple sensors incorporated within a single chip.
Figure 1: Traditional CMOS procedures [1].

Figure 2: Baolab’s concept using traditional CMOS process.
Advantages and Disadvantages

- They are small so they can fit just about anywhere in a relative perspective.
- Electrostatic effects can easily damage as compared to a component with a larger surface area.
- Less material to produce a product usually means a lower cost, however this depends on the material and the means of production.
- Less consumed energy.

Overall it seems that there are more advantages of MEMS and NEMS than disadvantages so an increase in practical application can be observed.
Applications of MEMS and NEMS

MEMs and NEMs devices are everywhere.
There are 15 to 20 MEMs devices for every person in North America.

- inkjet-printer cartridges
- accelerometers
- miniature robots
- microengines
- locks
- inertial sensors
- microtransmissions
- micromirrors
- micro actuators
- gyroscopes
- optical scanners
- fluid pumps
- transducers
- chemical sensors
- pressure sensors
- flow sensors
- disk drives
- servers
- components
- microphones
Applications of MEMS and NEMS

MEMs and NEMs have enabled the advent of many new devices. Many of these can be found in the medical field.

- Scalpels with embedded IC’s can measure pressure and cutting depth.
- Device have been manufactured to be implanted into patients to release the exact dosages of medicine at the correct time.
Applications of MEMS and NEMS

MEMS are enabling systems to restore sight for the blind. This article focuses on the increasing use of MEMS for treating diseases and injuries of the central nervous system (brain and spine), including paralysis, Parkinson’s disease, and drug-resistant depression.
Applications of MEMS and NEMS

Endoscopy probe that uses a MEMS scanning mirror to scan a laser beam and capture an image. Combined with Santec’s OCT technology this device is being applied to gastrointestinal and urological imaging as an alternative to biopsies in the detection of cancer and other diseases.
Applications of MEMS and NEMS

While MEMS and NEMS technology can be found in new devices, most applications of these technologies existed before their advent. These technologies make the products superior to their antiquated counterparts. They become more reliable, faster, and come at a lower cost.

Like BASF they don’t make the products you buy, they make the products you buy better.
Applications of MEMS and NEMS

Air Bag Control

- Airbags used to be controlled with relay logic
- Modern airbags are deployed with MEMs and NEMs accelerometers connected to a microprocessor.
Applications of MEMS and NEMS

Projectors

Modern digital projectors micromirrors to project images. Each mirror reflects one pixel on the screen. This technology is now being used to project high-definition movies at movie theaters (DLP).
Video

Applications of MEMS

http://www.youtube.com/watch?v=ZuE4oVrtEQY
References

References


