

A Review Paper on Micro-Electro-Mechanical Systems and Nano-Electro-Mechanical Systems

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Abstract: This paper provides a comprehensive review of recent developments and future prospects in micro-electromechanical systems (MEMS) and nano-electromechanical systems (NEMS). Also, we are going to promote how NEMS are advantageous over MEMS. Such systems have found application in field of robotics, optoelectronics, sensors, biomedical field. [1-4] Recent advances in both MEMS and NEMS are discussed, and focuses on applicability in such fields. MEMS are nowadays found application in iPods, computers, cameras, GPs etc[5].

The combination of MEMS and nanotechnology has the potential to create powerful and innovative devices and systems, ushering in a new era of technological progress this review provides insights into important developments in MEMS and nanotechnology and their potential impact in various industries.

Keywords: Micro-Electro-Mechanical Systems (MEMS), Nano-electromechanical system (NEMS), optoelectronics.

Introduction:

MEMS and NEMS have emerged as of the most unexpectedly growing and thrilling fields of studies and development in recent years. The capacity to design and fabricate micro- and nano-scale gadgets with complicated functionalities has opened up an enormous array of recent packages in regions including healthcare, electricity, and environmental tracking. The microscopic machines which are controlled by microelectronic circuits refer as micro-electro-mechanical systems (MEMS) [4,6].

MEMS technology includes the mixing of micro-electronics and micro-mechanics to create miniature devices which includes sensors, actuators, and microfluidic structures, while NEMS involves the layout and manipulation of substances and devices on the nanoscale. As we all know at nanoscale surface to volume ratio of material increases which enhances properties of material at nano-level. The mixture of those fields has the capacity to create even extra effective and modern devices and systems. This assessment presents an outline of recent advances and destiny possibilities in MEMS and NEMS, highlighting their capacity programs and discussing the mixing of those fields. [2,5]

Section I:

MEMS discuss with gadgets that integrate micro-scale mechanical additives, sensors, actuators, and electronics onto single chip [6,7] MEMS generation is primarily based on the standards of microfabrication, which involve the usage of micro-production strategies to create micro-scale devices. The early improvement of MEMS era changed into motivated by way of the want to miniaturize mechanical and electro-mechanical devices for numerous programs. The first MEMS devices have been easy structures such as cantilevers and diaphragms, which have been fabricated the use of conventional microfabrication strategies along with photolithography and etching. [6,7]

The second technology of MEMS gadgets noticed the introduction of more complex structures, including micro-actuators and micro-sensors. These gadgets had been designed to transform mechanical, thermal, or chemical signals into electric signals, or vice versa. The fabrication of these devices required the usage of superior micro-manufacturing techniques inclusive of deep reactive ion etching (DRIE), LIGA, and wafer bonding. [5-7]

The third era of MEMS gadgets concerned the combination of multiple components onto single chip, leading to the creation of greater complex structures such as microfluidic devices, micro-optical structures, and microelectromechanical systems (MEMS). These systems required the usage of more sophisticated microfabrication techniques, consisting of using sacrificial layers and multi-degree microfabrication. [1,3,7]

In current years, the fourth era of MEMS devices has emerged, which entails the mixing of MEMS technology with different fields such as nanotechnology, biology, and materials technological know-how. This integration has brought about the advent of even greater superior devices and systems, inclusive of lab-on-a-chip gadgets, nanomechanical

resonators, and biosensors. These gadgets have the potential to revolutionize numerous fields, together with healthcare, environmental tracking, and energy. [3,4,7]

Section II:

Nanotechnology involves the design, manufacture, and operation of materials and devices at the nanoscale, typically defined as a scale of 1 to 100 nanometers. In recent years, nanotechnology has enabled manufacturing processes, Material quality, and mechanical performance have improved significantly. Some of the current developments in nanotechnology are described below.

One of the most important advances in nanotechnology is the development of bottom-up processes such as self-assembly and molecular beam epitaxy (MBE). These processes use molecular-scale interactions to assemble materials and mechanical edge increases, resulting in higher order. Self-assembly techniques such as DNA origami have been used to fabricate complex nanoscale structures with high accuracy and order, while MBE has been used to fabricate materials as it is a good quality semiconductor. [7]

Another area of progress in nanotechnology is the synthesis of nanomaterials with unique properties such as carbon nanotubes and graphene. These materials have high mechanical properties, high electrical conductivity and exceptional optical properties, making them suitable for a wide range of applications in electronics, energy, biomedical etc. For example, carbon nanotubes have been used to make transistors of work well, once graphene has been used to make very fast and flexible electronic devices. [8]

Moreover, recent advances in nanotechnology have led to the development of new nanodevices with unique functions. For example, nanoscale sensors and actuators are being developed for use in health and environmental monitoring. These devices can detect and respond to a wide range of signals. [8]

Section III:

The combination of MEMS and nanotechnology led to the development of NEMS, which is a device that combines the mechanical and electrical properties of nanoscale structures. NEMS typically uses a bottom-up approach to fabricate structures at the nanoscale, then integrate them on a MEMS platform so optimize processes of control and implementation.

NEMS have several advantages over conventional MEMS devices, such as higher sensitivity, faster timing, and lower power consumption. This has led to its use in a wide range of applications such as sensing, action, and energy harvesting.

In addition to those technical advantages, the combination of MEMS and nanotechnology has also led to the development of new processes and materials such as carbon nanotubes, graphene, nanocrystalline diamonds etc. These materials offer unique properties that can be exploited role in the development of advanced NEMS devices.

Overall, the combination of MEMS and nanotechnology has enabled the development of highly flexible and efficient devices that can operate at the nanoscale. As the field moves forward, NEMS is expected to find applications in an increasing number of fields, including biomedical sensing, environmental monitoring and quantum computing.

Conclusion:

In conclusion, this review has highlighted the important developments in the fields of MEMS and nanotechnology, and their combination in the development of NEMS. These fields have revolutionized the way we design and fabricate devices, enabling us to create structures and devices at the micro- and nanoscale with unprecedented precision and efficiency.

The integration of MEMS and nanotechnology has resulted in the development of novel materials and fabrication techniques that have opened up new possibilities for advanced devices and systems. The emergence of NEMS has

enabled us to harness the unique properties of nanoscale structures in mechanical and electrical systems, leading to the development of highly sensitive and efficient devices with a wide range of applications.

Looking forward, the destiny possibilities for these fields are vast and exciting. The continued development of MEMS and nanotechnology will undoubtedly lead to the creation of even more sophisticated devices and systems, with applications in areas such as medicine, energy, and environmental monitoring. Moreover, the integration of NEMS with emerging technologies such as artificial intelligence and quantum computing is expected to lead to breakthroughs in areas such as robotics, sensing, and data processing.

In conclusion, the fields of MEMS and nanotechnology, and their combination in the development of NEMS, represent a rapidly advancing and highly promising area of research and innovation, with enormous potential for impact on society and the world.

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