# Chapter 3
# Carbon Nano Tube-Based Sensor Design for NEMS/MEMS Applications

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## ABSTRACT

*This chapter deals with designing CNT-based piezoresistive pressure sensors with different boss sizes and with different configurations designed for low pressure range. The purpose for this work is to show a NEMS-based pressure sensor, which was analyzed by using ANSYS 17 software. The different combination of the diaphragm shows the improved performance of the pressure sensor in the case of CNT as compare to the silicon. This chapter is organized in sections, where section 2 discusses the review of CNT based MEMS/NEM design process and applications, Section 3 elaborates the use of CNT materials for design piezoresistive pressure sensors, Section 4 discusses mathematical modeling and simulation of CNT-based piezoresistive pressure sensors, Section 5 examines the results and discussion in terms of linearity and sensitivity of designed sensor, and Section 6 consummates the chapter with the conclusion.*

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# 1. INTRODUCTION

## 1.1MEMS & NEMS Technology

MEMS has been observed as best growing technologies for the current century and has the capability to revolutionize both consumer and industrial products by combining CNT and silicon-based technology. NEMS (Nano Electro Mechanical) have the structure elements less than or below 100nm, this distinguishes NEMS from MEMS (Micro Electro Mechanical). There are different types of NEMS based devices, which are as from the simple stationary structure to the highly complex Nano system that contain the numbers of moveable parts under the control of integrated nanoelectronics. . The mostly used material for the NEMS and MEMS is the CNTs and Silicon because of its electrical properties, mechanical properties, physical properties as well as electromechanical properties.

## 1.2 MEMS & NEMS Components

MEMS represent integrated systems of very small size where the feature sizes are reducing to micron and nano dimensions. MEMS have unique features of sensing, actuation, manipulation, control and computation. Which all are integrated in the same system more important than this “size” characterization. Nano sensor, Nano electronics, Nano actuator, Nano structure are the main components of MEMS are given below in figure 1.Recently, NEMS and MEMS developers and researchers have demonstrated large number of Nano sensors, nanoactuators, micro sensors and micro actuators with improved performance. The size of MEMS device is in the range of 20 micrometers to millimeter and size of its sub-components is in the range of 1 to 100 micrometers whereas the size of NEMS devices are at the molecular level having the structure element less than or below 100nm. Typical active substrate material used for actuators and for sensors in microsystems or other MEMS components include silicon, gallium arsenide, germanium and quartz whereas the NEMS components includes the carbon Nano tubes, carbon Nano ribbons, graphene, etc. These are also beneficial for sensing devices, which can be good for the devices.

The functional elements of NEMS are miniaturized sensors, actuators, mechanical structure along with the microelectronics as shown in figure 1, among them Nano sensors and Nano actuators are the most notable elements.

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