

## Smart Micro/Nano Sensors and their Applications in Intelligent Sensory Network System

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Received date: August 23, 2017; Accepted date: August 24, 2017; Published date: September 01, 2017

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### Editorial

A comprehensive overview on the development of micro/nano sensors has been presented on the present/future trend, consumer needs, market demand and their exploitation in various technical fields. The emerging sensors and sensing technology will have dramatic impact on social and industrial revolutions. Indeed in past decade, the sensors technology has emerged as one of the fastest growing market (\$ billion dollar estimated in short span of 10 years) at consumer and industrial level like robotics, artificial intelligence, wearable technology, internet of things, automotive, mobile devices, smartphones, electric vehicles, medical and new emerging environmental technology [1]. In future, millions of nanosensors around us will play a dynamic role to monitoring the different activities in our daily life. Moreover, the new emerging sensors technologies based on transparent conducting oxide chemical sensors printed on flexible substrates can also revolutionize the idea and fulfill the demand at different scientific level.

The objective of this special issue is focused on chemical sensors and quartz crystal microbalance (QCM/QMB) sensors based on thin film and nanowires/nanomaterial to cover various aspects, such as tailoring of functional bulk/nano materials and fabrication of micro/nano sensors as a miniaturized/integrated sensing devices (resistive, conductometric, mechanical, capacitive, etc.) beyond the state of the art for monitoring the toxic compounds in growing and sustainable markets like food irrigation farm or industry, coal mine, oil & gas industry, including automobile industry.

The chemical sensors have been employed to detect the various harmful gases such as methane, ethanol, ozone, NO, hydrogen, carbon mono oxide, sulfur dioxide and multiple toxic Volatile Organic Compounds (VOCs) [2]. The various theoretical and experimental research models have been presented and discussed on sensing mechanism. The sensing phenomena mainly depend on "3S" parameter such as sensitivity, selectivity and stability [3]. In last couple of decades, researchers have centered their consideration and research endeavors on engineering the nanostructured materials for chemical detection at parts per million or parts per billion levels to improve the well-known "3S" parameter of a chemical sensor. Still there are lots of opportunities available at nano level to investigate the nanostructured nanowires or nanomaterial [4,5]. The chemical detection is the major key point for various applications for example in the domains of indoor air quality, healthcare, food security and environment etc. The cutting edge research on sensing at nano scale may prompt to revolutionize the developments that are important to improve the commercial devices at nano level [6]. There are many ways to optimize the benefit of chemical sensors. One can be the integration of chemical sensors in matrices or array network for the examination of the

coordination of chemical compounds or cluster of hazardous gases [7]. The chemical sensors based on oxide materials usually work at high temperature and there is a possibility to investigate the functional nanostructured materials which can work at room temperature to detect the multiple airborne toxic chemical compounds [8].

Similarly QCM/QCB sensors and their matrices or arrays can be employed to detect the hazardous chemical compounds or VOCs gases at room temperature. QCM sensors work on piezoelectric effect which measures a variation in mass per unit area by recording the change in frequency of a quartz crystal [9,10]. In addition, the integration of sensors in arrays like miniature device has been advantageous solution for the analysis of complex chemical compounds in real time domain [11].

The creative and innovative steps can bring an interesting move in the sensors field, by supporting the advancement of devices where various kinds of sensors (hybrid sensory network) can be fabricated together for the interpretation of chemical patterns made from unknown complex compounds. The electronic nose based on QCM sensors follows the artificial olfaction system and can be employed in food supply chain industry, environmental and medical diagnosis purposes [12]. The further technical advancement in instrumentation/production facilities can bring the fabrication and packaging cost down which can play a dynamic role in the new emerging sensing technology. The predictive analysis, data modeling, protocols can be developed and effectively employed as sensing data transfer from sensory network to fulfill the requirement of the technology.

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