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Editorial Open Access

Nano/micro Sensors and Effective Energy Sources for Communication and Wireless Sensor Networks

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Editorial

Significant advances in sensing, computing and communication technologies have led to the development of tiny, low power and powerful sensor nodes called wireless sensor networks (WSNs). Our scope covers a wide range of engineering and technological topics in the area of energy sources as well as micro sensors such as nano-electromechanical/micro-electromechanical systems (NEMS/MEMS) sensors and micrometer-scale energy sources, i.e., energy harvesting devices for communications and sensor networks. NEMS/MEMS sensors for communications include accelerometers, magnetometers, gyroscopes and pressure sensors. Such sensors have been integrated in the last few years in portable devices because of their low cost, small size, low power consumption and high performance. In particular, Inertial sensing technologies in high temperature environments over 500°C are in great demand in aerospace, power plants and material processing applications. However, conventional NEMS/MEMS sensors still cannot be operated at such high temperature area and need to be isolated in controlled environments.

Gallium nitride (GaN) is very promising for high power devices, high temperature electronics and microsystems due to their wide energy bandgap with low intrinsic carrier density at high temperature over 500°C. Thus, a technology platform based on GaN technology capable of operating at the high temperatures. All the desired sensors (temperature, pressure, positioning, etc.) are realized in the same GaN technology together with the electronics required for sensing, actuating and communication. By integrating the sensors and electronics together, in one platform, flexibility in size of the sensors enables more powerful sensor nodes for WSNs. In particular, in terms of the technology for building a transceiver operating at radio frequencies (RF) GaN is also the preferred choice for sensor network systems under high temperature environment. The key performance parameters for transistors in RF, digital and high-speed mixed-signal applications include cut-off frequencies, current drive capability (or output charging rate) and voltage drive capability (maximum output voltage swing). The unity current gain cut-off frequency (f_T) is proportional to the reciprocal of the transit time t, the effective time required by charges to transit the channel. The output current drive is proportional to the charge in the channel, and is inversely proportional to t. Reduction in t has been the fundamental driver responsible for dimension scaling in silicon-based transistors, which has seen the physical size of the gate shrink from hundreds of micrometers (μm) in the 1950's to about 14 nm in the most current 14-nm node CMOS transistors. The data collected from the sensors through the GaN transceiver should reach the external terminal for the virtual map. Wireless or radio transceivers have small footprint and require less power for sending radio signals. In addition, instead of sending the data directly to the terminal, the data can be sent from each sensor node, to its neighbor, until it reaches the external terminal. It is ascribed to the low power consumption needed in the second approach and the limited volume required for a battery to bias the transceiver. Multiple antennas and beam-steering/beam-forming are supposed to effective. The choice for the frequency of operation is related to the dimensions of the antenna and the existence of free bands.

The past few years have seen an increasing focus in the research community on small wireless electronic devices. Wireless sensor nodes are computational devices equipped with sensing, data acquisition, processing and wireless communicating abilities. Furthermore, wireless sensors usually use batteries as their power sources which can provide only short lifetime and limited capacity. In addition, the replacing the batteries and re-charging them in some applications may be difficult and costly. Renewable energy sources become a promising solution to improve one of the major challenges for the WSNs, which is keen to the network lifetime. The process of converting ambient energy sources such as solar energy, heat, wind, and mechanical vibrations into viable electrical energy is called 'Energy harvesting' based on piezoelectric properties of the materials. Capturing minute amounts of energy from one or more of the ambient energy sources, accumulating them and storing them for later use is defined as energy harvesting.

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