Abstract

Energy efficient miniaturized devices with enhanced sensor performance for system-on chip application are the present need. The thesis overcomes the challenges of risky high voltage operation, bulky, complex device architecture, unstable and irregular signal output and high-power consumption of ionization based sensors through the design, and development of cantilever type corona discharge (CD) mediated dielectric breakdown (DB) based devices with an array of polySi micro-tips as the top electrode. The sharp micro-tip corners and the narrow inter-electrode gap facilitate in the generation of high electric field E~10 MV/m sufficient to cause DB at low bias voltage V_b=10 V. DB is associated with avalanche free ionization process and collision less transport which helps to achieve stable and controlled output signal. The mechanical stability of the cantilever type device against external vibrations was reduced through design of dual beam structure. This dual beam architecture increases the effective width of the suspended beams and reduces the cross-axis vibration due to their anti-directional twisting. The phenomenon of DBAI is utilized in the development of (a) ambient pressure sensors, (b) chemical recognition and concentration determination of leakage gas (L-gas) and (c) food storage environment (FSE) monitoring. The e-avalanche less DB assisted ionization (DBAI) and collision free transport provided fast response, increased electrical stability, and reduced hysteresis error in the output signal current and thus utilized for real time ambient pressure monitoring in the wide dynamic range (DR) of 10^{-4}-50 mbar. Continuous food storage environment (FSE) monitoring device was realized on a single chip through the integration of temperature (TSEN) and CO_2 sensors, where they independently monitor the respective variations in temperature and CO_2 gas concentrations in storage ambience. The TSEN and CO_2 sensor operate in a wide dynamic range of 253-303 K and 0.05-1 pp respectively and can be used for monitoring FSE of wide variety of food products. The thesis also demonstrates the development of DBAI based sensing platform for diverse gases using the multi-tip devices. Owing to the chemical selectivity of DBAI to different gases, the GSEN was integrated with TSEN for recognition and detection of various binary mixtures of leakage gases in air. The major contribution of the thesis lies in the design and development of DBAI based miniaturized, and energy efficient devices for system on chip applications.