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Room temperature gas-sensing properties of multi-walled carbon-nanotubes functionalized with phthalocyanine

Anshul Kumar Sharma, R K Bedi and Aman Mahajan
Guru Nanak Dev University, India

Multi wall carbon nanotubes (MWCNTs) have attracted extensive attention in sensing and storage of gases due to their unique one-dimensional carbon nanostructure and electrical properties. On the other hand, due to their high surface areas, central hollow cores and the outside walls, carbon nanotubes can be used as a superior material to adsorb and storage gases, such as oxygen, hydrogen, chlorine and nitrogen oxides. CNTs can respond to both reducing and oxidizing gases through a charge transferring reaction with the gas molecules that changes their conductivity. Multiple research groups have focused on studying and improving the response of CNT-based sensors. Recently, in order to improve the sensing performance of these MWCNTs based sensors, many sensing materials such as conducting polymers, metals and metal oxides have been anchored on the surface of MWCNTs and play important roles in the improvement of the sensitivity and selectivity of the resultant gas sensors. Phthalocyanine (Pc), as an excellent sensing material, has been extensively studied based on its high sensitivities, excellent thermal and chemical stability. The electrical conductivity of phthalocyanine thin films can be changed by the presence of oxidizing or reducing gases. In this work, we have prepared a hybrid material of MWCNTs-COOH and F_{16} CuPc. The formation of F_{16} CuPc/MWCNTs-COOH hybrid was confirmed by UV-Visible, Raman and FT-IR spectroscopy. SEM, TEM and AFM studies revealed that F_{16} CuPc molecules were successfully anchored on the surface of MWCNTs-COOH through π - π stacking interaction. Subsequently, a chemi-resistive sensor have been fabricated by drop casting F_{16} CuPc/MWCNTs-COOH hybrid onto alumina substrate. The gas sensing potential of the fabricated hybrid materials has been tested upon exposure to different hazardous gases like NO_2 , NO, Cl_2 and NH_3 at different operating temperatures. It has been demonstrated that F_{16} CuPc/MWCNTs-COOH hybrid is highly selective towards Cl_2 with minimum detection limit of 100 ppb. The response of sensor increases linearly with increase in Cl_2 concentration. The results obtained emphasize on the application of F_{16} CuPc/MWCNTs-COOH hybrid material in Cl_2 sensing applications.

anshulsharma.phy@gmail.com

High-K/Metal Gate (HK/MG) stacks on high mobility channel substrates for advance CMOS technology

Ashok Mahajan
North Maharashtra University, India

In the several years, there is enormous development in the complementary metal-oxide-semiconductor (CMOS) technology. To follow the ITRS projected parameters and Moore's law, the Ge has attracted much attention due to its higher carrier motilities than silicon for high mobility channel devices. Further, Ge/high-k technology is in account, with different passivation techniques to form an intentional interfacial layer between Ge and high-k. In this context, we have deposited and studied various structural and electrical properties of high-k dielectrics on Ge and SiC. Initially, the high-k thin film of HfO_2 was deposited by using Plasma Enhanced Atomic Layer Deposition (PE-ALD) technique on Ge. The electron beam evaporation system was used to deposit the Ti/Pt metal bilayer to fabricate the Pt/Ti/ HfO_2 /Ge MOS capacitors. Further, the ZrO_2 and HfO_2/Al_2O_3 ultra-thin films were deposited on p-type (100), (110), (111) Ge by using the plasma enhanced atomic layer deposition (PEALD) and Ti/Pt. Cr/Au have been deposited using ebeam evaporation system to form the MOS structures. The XPS has been used to study the composite properties of these deposited films. HRTEM and AFM used to study the interface and surface morphology. The C-V and I-V measurements were used to calculate the dielectric constant, barrier height, effective oxide charge and density of interface traps of the fabricated different MOS structures. In addition to this, the study of ZrO_2 high-k dielectrics on 4H-SiC have also been carried out. Overall, the different novel HK/MG gate stacks have been studied for their suitability for CMOS technology.

ammahajan@nmu.ac.in