Abstract

In this work synthesis and characterization of graphene based materials were undertaken with an aim to use them as charge trap elements for nonvolatile memory (NVM) applications. Essentially, graphene oxide (GO), GO-silver nanoparticles (SNPs) composites and graphene quantum dots (GQDs) were prepared, characterized and used as charge trapping elements under field effect modes to understand the transport properties and memory behaviour. GO, the most popular derivative of graphene was synthesized by Hummers' method. The dielectric nature GO was exploited for the successful implementation of low-power pentacene based field effect transistor. The performance of the devices was analyzed from their field-effect characteristics. The current transport mechanisms are explained from the output characteristics using the Fowler-Nordheim tunneling mechanism. The charge storage capability of GO were investigated from the capacitance-voltage (C−V) characteristics which shows the suitability of the device for memory applications. The reduction of GO was carried out by decorating SNPs over GO surface and then thin film transistors (TFTs) were fabricated to understand the transport properties. In this study, the devices were found to operate in the ambipolar mode. Chemical functionalization in GO was introduced by making composites with SNPs for memory devices. In GO composites, memory window was found to increase with increasing SNPs wt % in GO matrix. Memory behaviour was observed due to enhanced scattering and defects introduced by SNPs into the layers of GO. We have investigated the memory characteristics of GQD based NVM devices prepared using PMMA as a tunneling and control dielectric material. GQDs were prepared by solvothermal method. Maximum charge trap density was observed with GQD device because GQDs acts as discrete charge trap nodes. Size dependent charge storage behavior of GQDs were demonstrated by using pentacene as an active semiconductor on flexible substrate, kapton. It is observed that with increasing the size of the GQDs, memory window is found to decrease. With increase in the size of the GQDs charge retention property is enhanced in the devices. The effect of annealing temperature of GQDs on memory window was also studied.

Keywords: Graphene oxide, Nanocomposites, Quantum dots, Charge transport, Memory.