SIMULATION STUDY OF A NEW AMORPHOUS SILICON THIN FILM TRANSISTOR WITH TETRAHEDRAL AMORPHOUS CARBON AS GATE DIELECTRIC.

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Abstract

Macroelectronics or large area electronics, which comprises of technologies including amorphous and organic semiconductors based devices are growing rapidly. It is expected that by 2015, these technologies cumulatively would have a market of around US $ 300 – 500 billion. However these technologies have so far grown under the shadow of the dominating silicon technology. So far the key driving force has been the display technology and the associated amorphous silicon technology. However as we move towards more flexible electronics, and lower temperature process, there is a need to relook into the various material and process issues. Recently amorphous silicon has been grown under lower temperature conditions using diverse processes with temperature ranging around 100 to 150 ^{0}C. However we now need to also look for dielectrics which would be ready for such low temperature process as we move towards flexible electronics. This calls for novel dielectrics, besides the enhancement in the properties of the amorphous silicon or even the organic semiconductors. In an effort to address the above issue of low temperature processed dielectric, we have tried to simulate amorphous silicon TFTs with carbon based material as dielectric.

We have been recently able to grow carbon films with properties varying from insulating to semiconducting (conductivities varying from 10^{-13} to 10^{-3} Ω^{-1} cm $^{-1}$). The morphology of the films could be varied from atomic smooth films to clusters, pillar like structures and fibers, by varying the deposition parameters. These depositions were carried out with the initial substrate temperatures vary from room temperature to 100^{o} C. The properties of the resistive carbon films under varying thickness conditions from 100 to 1000 A were used as the main variable to simulate amorphous silicon TFTs. The relatively optimized standard properties of the hydrogenated amorphous silicon were obtained from the literature for the simulation studies. The study show that these devices can possibly deliver around 10^{4} order change in ON and OFF currents. There is not much change in the turn on voltages. Hence these carbon films with structure varying from amorphous to nanostructured and grown at relatively low temperatures could be interesting material for consideration for future amorphous silicon TFTs, especially on flexible substrates.