Thin film transistor using GaN nano particles

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The recent development of transparent thin film transistors (TTFTs) represents a major advance in the emerging field of transparent electronics. These transistors have been fabricated on the basis of crystalline oxide channels that are typically produced at relatively high processing temperatures. However, here are few reports on using GaN as the channel materials for TTFT. GaN is a direct wide band gap semiconductor material. The band gap is 3.4 eV which is similar to ZnO. GaN epi-layer is widely used on HEMT, MESFET and other electrical devices. Compared to other TFT material, GaN has high mobility and saturation velocity. This work focuses on TFT devices based on nano GaN particles.

High purity and high crystalline GaN particles is made in the lab by reaction between molten Ga and ammonia while bismuth is used as the wetting agent. The purity of this lab-made GaN powder is higher than 99.9% based on glow discharge mass spectrometry analysis. The particles size distributes from less than 1 um to more than 10 um. These particles are further treated into nanometer region through the size reduction process developed by Primet.

Those nano GaN particles could be further placed on the different substrates via spin coating process. Due to the simple requirement of spin coating, various substrates could be adapted in this application, such as: glass, Si, sapphire, etc. Methyl cellulose (MC) is used as a dispersant for nano GaN particles in the spin coating process. Nano GaN particle can be successfully disaggregated and dispersed into water with the aid of MC. Then the colloidal dispersion is spun on glass or Si substrates. The dispersant can be removed by annealing process at 450^{o}C. Laser annealing technique could further reduce the thermal budget. After these processes, a uniform GaN layer is deposited on the substrate. XRD data shows the particles to be highly orientated in (0002) direction.

Simple back gate TFT devices have been fabricated. Ti/Au is used for contact. About 4nA saturation current has been achieved with 500um channel length with gate floating. Detail electrical performances will be presented in the presentation.