Amorphous Metal Oxide Semiconductor Thin-Film Transistors

Tze-ching Fung, Charlene Chang, Kenji Nomura, and Jerzy Kanicki

Amorphous metal oxide semiconductor (AMOS) is a unique material which is emerging as the new candidate for next generation thin-film transistor (TFT) technology for flat-panel displays and imagers. Its conducting mechanism is insensitive to bond angle variance induced by structural randomness and enables AMOS to have a high mobility even in amorphous phase. Among various AMOS, we choose for our research amorphous InGaZnO$_x$ (a-IGZO), a wide band-gap (~3.2eV) semiconductor. Because it contains a heavy post-transition-metal (primarily In) and defect inhibitor (Ga), highly intrinsic a-IGZO thin film with high carrier mobility desired for TFT application can be made.

In collaboration with the Tokyo Institute of Technology (Dr. K. Nomura, Japan), we have studied the fundamental a-IGZO TFT electrical performances on inverted staggered structure composed of n$^+$ Si substrate (gate), thermal SiO$_2$ layer (gate insulator), a-IGZO channel layer and top gold electrodes (source/drain). We can achieve switching properties comparable to a-Si:H TFT with low off-current ($10^{-11}$~$10^{-12}$A), small subthreshold swing (355mV/dec) and high on/off ratio on the order of 10$^6$. The field effect mobility up to 8cm$^2$/Vs has been observed with threshold voltage ranging from 1V to 5V. The above device results are suitable for flat-panel displays. We expect the a-IGZO TFT electrical performance can be further improved by proper optimization of the device structure and a-IGZO processing conditions. This project is partially supported by the Defense Advanced Research Projects Agency and Applied Materials, Inc.