

## Intelligent Silicon Field Emission Arrays

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We report the combination of a semiconductor microelectronic device with a vacuum microelectronic device to obtain low voltage switching and more stable emission in field emission devices. Instead of the traditional feedback resistor stabilization in the emitter circuit, a MOSFET is used as a voltage controlled current source thereby stabilizing the emission current and resulting in low voltage switching. In this device, the emitter electrode of the field emission array is combined with the drain of the MOSFET. The device operates by controlling the electron supply to the emission surface through the inversion layer density in the channel region of the MOSFET. However, the device is only effective in reducing noise when the MOSFET is biased in the saturation regime. Our devices were fabricated using isotropic etching, oxidation sharpening and chemical mechanical polishing as reported earlier [IVMC- Ching-yin Hong].

Electrical characterization of integrated MOSFET/FEAs devices was conducted in UHV at a pressure of  $1 \times 10^{-9}$  Torr. The average turn-on voltage of FEAs is 24V. The threshold voltage of a LD-MOSFET is about 0.5 V. The gate oxide thickness is 50nm and the electron mobility in the transistor is calculated to be  $430 \text{ cm}^2/\text{V}\cdot\text{sec}$ . The subthreshold slope is 98.6 mV/decade. MOSFET/FEA is off when the transistor gate voltage is below threshold. At a transistor gate voltage slightly above the threshold voltage, the emission current initially is controlled by the transmission through the tip barrier. As FEA gate voltage increases, the emission current saturates indicating that emission current is controlled by the electron supply from the inversion layer.

We demonstrated the control of electron emission current from a field emission array by the gate voltage of a LD-MOSFET. In the integrated device, emission current could be switched by voltages smaller than 1V. The emission current was also stabilized by the MOSFET.

Figure 1. TEM of a silicon tip.

Figure 2. Fowler-Nordheim plot of an integrated MOSFET/FEA device.

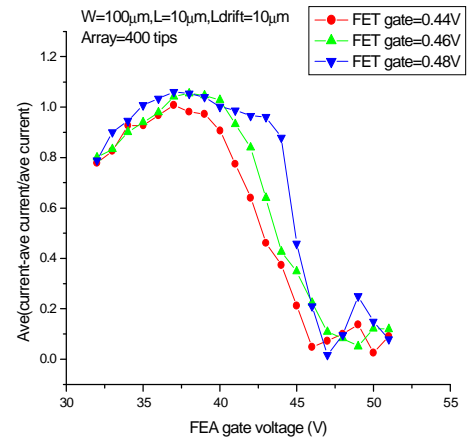


Figure 3. Current fluctuation in a LD-MOSFET / FEA showing differences between the operating regimes.

