Researchers at Swansea University in the UK and the University of Nis in Serbia claim the first fabrication of gallium nitride (GaN) magnetic high-electron-mobility transistors (MagHEMTs) [S Faramehr et al, Semicond. Sci. Technol., vol33, p095015, 2018].

The devices featured a split drain (Figure 1) that allowed the deviation of electron paths due to interaction with magnetic fields to be assessed. The relative sensitivity of such devices is given by the current difference between the drain terminals relative to the total drain current over the magnetic field in Teslas (T).

Magnetic sensors are widely used for control in engineering systems covering aeronautical, automotive and industrial applications.

The devices were fabricated on HEMT heteroepitaxial structures with Al_{0.25}Ga_{0.75}N barrier layer. Step-graded AlGaN was used to transition from the silicon substrate.

The researchers used the experimental results to calibrate a series of simulations aimed at optimizing performance. The model suggested that improved sensitivity of 23.29%/T, at zero gate potential and 0.5V drain bias, could be achieved in a device with altered parameters - L=65µm, W=20µm, L_S=5.5µm, W_S=5.0µm, W_D=5µm, L_G=5.0µm and L_GD=10µm.

Figure 1. GaN MagHEMT (split-current sensor) schematic showing geometrical parameters used for relative sensitivity optimization.
The important changes seem to be a much longer total length of 65µm and reduced source width of 5µm. The reduced source contact decreases the total current flow and increases sensitivity to current deflection effects. The longer length also increases source to drain resistance, again reducing total current. The simulations also suggest an order-of-magnitude enhanced sensitivity at around –4V gate potential.

The researchers further studied the simulations at a raised temperature of up to 500K, showing “promising operation of GaN magnetic sensors under harsh environments”. However, there was a decrease in sensitivity to 4.91%/T for the original device structure.

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