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Radiation Hard AlGaN/GaN Heterostructure- Micro-Hall Sensors

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Hall effect magnetic sensors are widely used and integrated in systems including automotive, biosensors, and scanning Hall probe microscopy (SHPM). Hall sensors are also promising for space applications, where size and power consumption are important, in such extreme environments Hall sensors must withstand high temperatures and radiation. GaN based Hall sensors are good candidates for use in harsh environments because of the high displacement threshold energy of GaN compared with Si and GaAs.

AlGaN/GaN micro-Hall sensors were fabricated using metal organic chemical vapor deposition by depositing 2 μm GaN on an AlN buffer layer followed by a 25 nm layer of unintentionally doped (UID) $Al_{0.25}Ga_{0.75}N$ layer, and Ti/Al/Ni/Au was used as ohmic contacts. We also studied devices with a Si doped top AlGaN layer (Si-doped micro-Hall sensor). The micro-Hall effect sensors were irradiated with 380 keV protons and fluencies between 10^{11} to 10^{14} (proton/cm^2) using an ion-implantation facility at Takasaki Ion Accelerators for Advanced Radiation Application.

Figure 1(a) shows the variation of the magnetic sensitivity with proton fluence irradiation. The magnetic sensitivity was relatively stable with increasing proton fluence. The minimum detectable magnetic sensitivity, shown in Figure 1(b) increased slightly with increasing proton fluence due to the sample resistivity, increasing caused by the GaN crystal damage and defect generation due to high proton irradiation. The reliability slightly varies after high proton fluence irradiation due to the high electron density of the AlGaN/GaN heterostructures and high displacement threshold energy of the GaN.

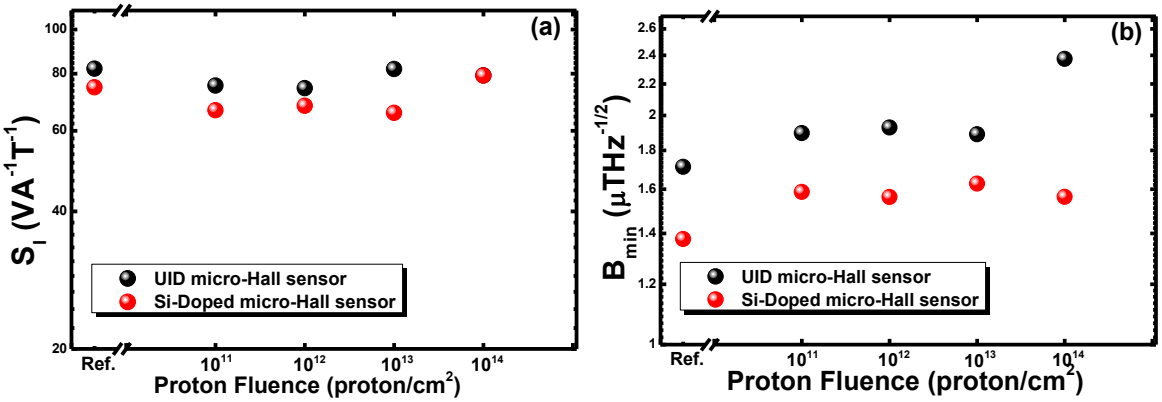

Figure 1. Proton fluence dependence of (a) the magnetic sensitivity and (b) the minimum detectable magnetic field, in AlGaN/GaN heterostructures based micro-Hall sensors.