Trade-off between Hall sensitivity and frequency limit of 2DEG Nitride Hall Effect Sensor

Satish Shetty[1], Ayesha Hassan[2], Yuriy I. Mazur[1], H. Alan Mantooth[2], and Gregory J. Salamo[1]

[1]Institute for Nanoscience and Engineering, University of Arkansas, Fayetteville, AR, 72701, USA

[2]Department of Electrical Engineering, University of Arkansas, Fayetteville, AR, 72701, USA

We demonstrate the tradeoff between Hall sensitivity and frequency bandwidth of AlGaN/GaN micro-Hall-effect sensors. The micro-Hall-effect sensors used in this study exhibit temperature stability from 30 to 400 °C. To highlight the trade-off between Hall sensitivity and frequency response of III-nitride Hall sensors, we employed three different heterostructure designs. These designs had variations in sheet carrier density, carrier mobility, sheet resistance, and capacitance. By varying the Hall device carrier velocity, carrier density, and inbuilt capacitance, investigate the tradeoff between Hall sensitivity (S_{svrs}, S_{scrs} and S_{sprs}) and frequency limit in terms of Hall signal rise time and phase shift. Additionally, we propose a method to address the frequency limitation that arises from the current spinning technique. This method involves measuring the induced voltage at the Hall measurement terminal, which results from the time-variable magnetic field, without applying any external bias to the Hall sensor.

To understand the fundamental physical parameters correlation between phase shift correspondence of Hall-offset, and Hall voltage with reference to bias signal. To explore this investigation, we looked into following evidence: i) the phase shift of the Hall offset by varying the frequency of the input bias voltage, and ii) examine the response of the Hall voltage in relation to the magnetic field and the frequency of the applied bias voltage. The data presented in Fig. 1(B) reflects the phase shift in Hall offset for the series of Hall sensor devices. However, the observed phase shift with reference to applied frequency of bias voltage can be attributed to the device conductive channel time constant (τ) of Hall-effect sensor. The sensor which has low sheet resistance and low RC time constant shows lower phase shift. Similarly, the phase shift observed in the Hall voltage relative to the Hall offset is influenced by the strength of the applied magnetic field, which in turn affects the magnitude of the Hall voltage and the sensitivity of the Hall device.

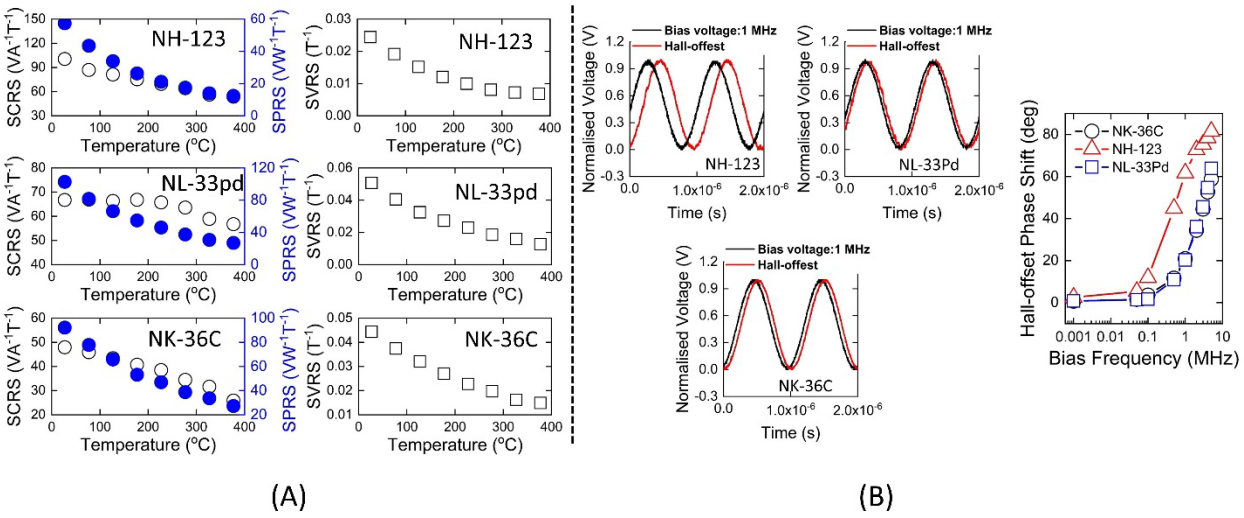

Fig. 1. The measured **(A)** SVRS, SCRS, and SPRS for three AlGaN/GaN micro-Hall sensor as a function of temperature, **(B)** Investigation of frequency band width three different type of AlGaN/GaN micro-Hall sensor.