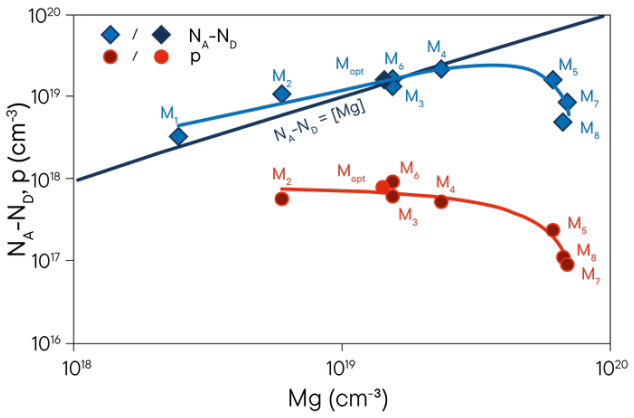
Optimization of p-GaN Electrical Properties by Hall Effect Measurements

Characterization of Mg-Doped GaN for Power Electronics Applications

Hall effect measurements are essential for evaluating charge carrier concentration, mobility and resistivity in semiconductor materials. In this application example, Mg-doped GaN layers grown by hot-wall MOCVD were analyzed using the LINSEIS HCS L36. The measurements demonstrate the influence of Mg doping on free-hole concentration and electrical performance of p-type GaN for power electronic devices.

Measurement Setup

- Instrument: LINSEIS HCS L36 Hall Effect Measurement System
- Material: Mg-doped GaN
- Measurement: Hall Effect (Van der Pauw)
- Parameters: Free-hole concentration, mobility, resistivity
- Application: Power electronics and semiconductor devices



The Hall effect measurements reveal a strong dependence of electrical properties on Mg concentration.

Key observations include:

- Free-hole concentrations up to 8.9 × 10^{17} cm^{-3}
- Lowest resistivity of 0.77 Ω·cm achieved under optimized growth conditions
- Significant reduction of free-hole concentration at excessive Mg doping levels
- Correlation between Mg activation and electrical performance
- Valuable guidance for optimization of p-type GaN growth processes

The results demonstrate the suitability of Hall effect measurements for evaluating carrier transport properties and optimizing semiconductor materials for high-performance electronic applications.

Interpretation

The observed electrical behavior can be attributed to:

- Mg acceptor activation
- Compensation effects at high Mg concentrations
- Influence of crystal quality

This results in:

- Higher carrier concentrations
- Lower resistivity
- Improved electrical performance

Industrial Relevance

Hall effect measurements support:

- Development of GaN power devices
- Optimization of semiconductor growth processes
- Quality control of epitaxial layers
- Research and development of wide-bandgap semiconductors
- Electrical characterization of advanced electronic materials

Conclusion

The LINSEIS HCS L36 enables precise determination of carrier concentration, mobility and resistivity in semiconductor materials. The measurements highlight the importance of Hall effect characterization for optimizing Mg-doped GaN and accelerating the development of next-generation power electronic devices.

Source:
Papamichail, A., Kakanakova-Georgieva, A., Sveinbjornsson, E. O., Persson, A. R., Hult, B., Rorsman, N., Stanishev, V., Le, S. P., Persson, P. O. Å., Nawaz, M., Chen, J. T., Paskov, P. P., Darakchieva, V. Mg-doping and free-hole properties of hot-wall MOCVD GaN.
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Adapted from Hall effect measurements performed using a LINSEIS HCS 1 (current designation: HCS L36).