

Supplementary Material to the article

“Magnetoresistance and symmetry of two-dimensional electron gas of AlGaN/AlN/GaN heterostructures”

Shubnikov–de Haas oscillations are experimentally shown to depend on the direction of current flow with respect to the GaN crystallographic axes. This study allows to supplement the ARPES data [1] with a set of independent results.

High accuracy of the measurements, repeatability of the data taken at different times, as well as the absence of hysteresis in the magnetic field are to be noted. The arrangement of contacts in these measurements was as follows: - potential contacts: No. 1 - 0° , No. 2 - 15° , No. 3 - 30° , No. 7 - 180° , No. 8 - 195° , No. 9 - 210° ; - current contacts: No. 4 - 90° , No. 10 - 270° , see Fig. S1.

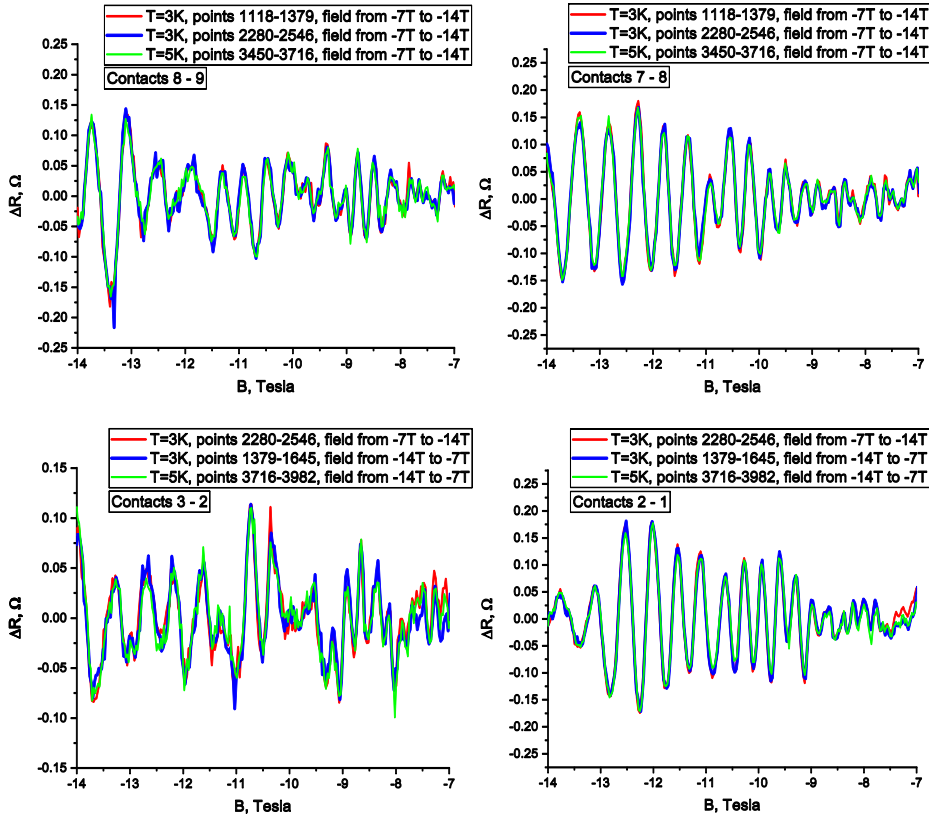


Fig. S1. Magnetic field dependences of ΔR_{xx} - 2DEG magnetoresistance with its main stroke subtracted for different directions of current relative to the crystallographic axes: (7-8) and (8-9) differ by 15° (sample with electron density of $2 * 10^{13} \text{ cm}^{-2}$, temperatures 3K, 5K) Curves shown in blue and red were taken at different time passes with a difference of tens of hours.

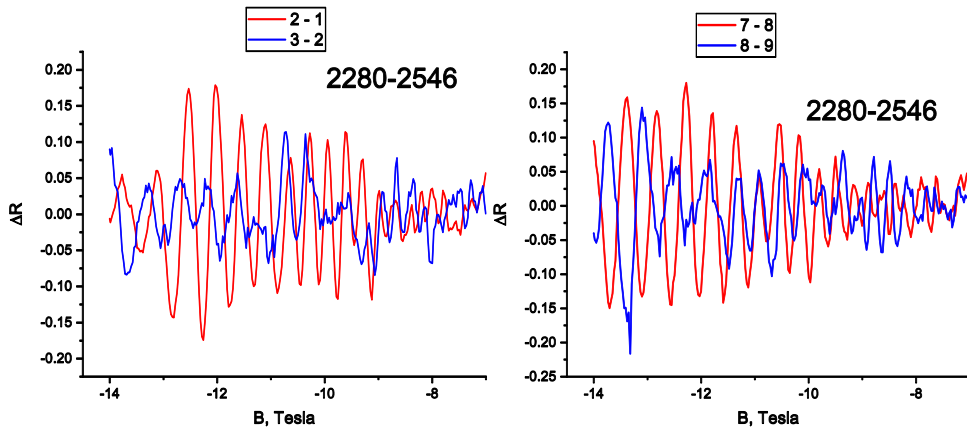


Fig. S2. Magnetic field dependences of ΔR_{xx} - 2DEG magnetoresistance with its main stroke subtracted for different current directions with respect to the crystallographic axes. The orientation of the circle sectors (2-1) and (3-2), as well as (7-8) and (8-9) differ by 15° (sample with electron density of $2 \cdot 10^{13} \text{ cm}^{-2}$, temperature 3K). The red curves corresponding to sectors (2-1) and (7-8), and the blue ones - (3-2) and (8-9), are located on the opposite sides of the circle relative to each other.

In the Shubnikov–de Haas oscillations region, the dependences of the magnetoresistance $R_{xx}(B)$ for different sectors of the ring-shaped sample located opposite each other are close, while it is significantly different for neighboring sectors with 15° orientation difference, Fig. S2.

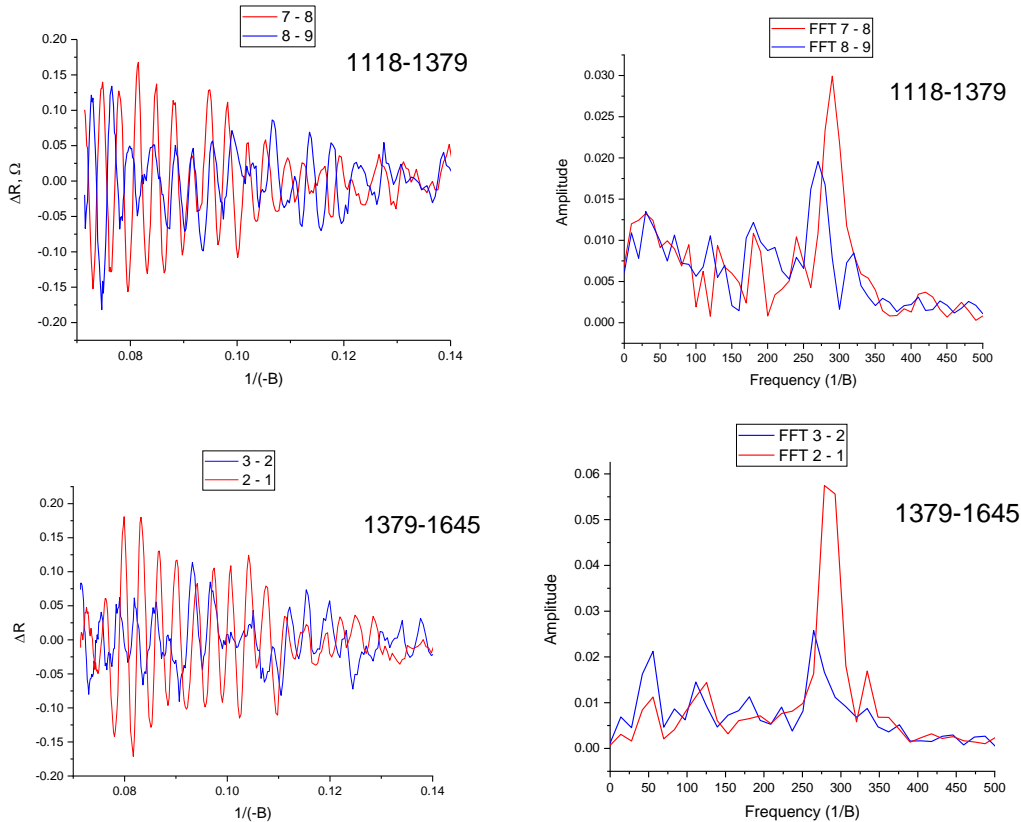


Fig. S3. Reverse magnetic field dependences of the 2DEG magnetoresistance ΔR_{xx} and their FFT spectra.

References

1. L.L. Lev, I.O. Maiboroda, M.A. Husanu, E.S. Grichuk, N.K. Chumakov, I.S. Ezubchenko, I.A. Chernykh, X. Wang, B. Tobler, T. Schmitt, M.L. Zanaveskin, V.G. Valeyev, and V.N. Strocov. **k**-space imaging of anisotropic 2D electron gas in GaN/GaAlN high-electron-mobility transistor heterostructures. *Nat. Commun.* **9**(1), 2653 (2018).