Experimentally Determining the Magneto-resistance Tensor of Unintentionally Doped (010) β-Ga_2O_3 (AGSR_96)

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The beta-phase of gallium oxide (β-Ga_2O_3) is a promising material for next generation power electronics due to its ultra-wide bandgap of 4.5 – 4.8 eV and ease of high-quality bulk growth with melt-growth techniques. The crystal structure of β-Ga_2O_3 is monoclinic with *C2/m* space group. Due to the low symmetry of the material, possible anisotropy in charge transport can be expected. Therefore, in this work, four-point probe and Hall effect measurements were performed on unintentionally doped (010) β-Ga_2O_3 bar-shaped substrates diced along [001], $[100]^*$ and $[001]^*$ directions to determine the elements of material's magneto-resistance tensor. No notable anisotropy has been observed in the electrical conductivity as the difference in the in-plane resistivity was within 3%. The measured Hall voltage was corrected for non-ideal effects such as misalignment, Seebeck, Nernst, and Righi-Leduc effects. Among the four, misalignment of contacts was found to be the dominant non-ideal effect. At room temperature, Hall electron concentration and mobility were ~ 7-8 × 10^{16} cm^{-3} and 130 – 140 cm^2 $V^{-1}s^{-1}$, respectively. The results of Hall electron mobility among the samples were within 4 – 10 %. The larger difference in mobility could be attributed to the direction-dependent electron-phonon coupling strength in β-Ga_2O_3. Due to the monoclinic structure of β-Ga_2O_3 and orthogonal coordinate system required for the magneto-resistance tensor calculations, the elements of the tensor denote the values along one crystallographic axis ($\boldsymbol{c}$ or $\boldsymbol{a}$) and a direction orthogonal to it ($\boldsymbol{a}^*$ or $\boldsymbol{c}^*$). Using the experimentally measured values for $\boldsymbol{c}\boldsymbol{a}^*\boldsymbol{b}$ – system, we found the values for $\boldsymbol{c}^*\boldsymbol{a}\boldsymbol{b}$ – system using a matrix transformation. A 3 % difference was observed between the experimentally measured values and the ones obtained through the matrix transformation.