# Circularly polarized electroluminescence properties of quantum dot spin-polarized light-emitting diodes using GaNAs spin filter

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For the development of the advanced information society utilizing Artificial Intelligence and Big Data, the information systems are required to reduce the electric power consumption. Opto-spintronics has attracted attention due to the optical communication of spin information [1]. A spin-polarized light-emitting diode (LED) is the key device which can directly convert electron spin polarization to circularly polarized light, however the conversion efficiency has never been high. We have recently demonstrated the room temperature operation of spin-polarized LED using III-V semiconductor quantum dots (QDs), which can suppress the spin relaxation during light emission [2]. In this study, we investigate the electroluminescence (EL) properties of a QD spin-polarized LED using GaNAs spin filter. Recently, a tunnel-coupled structure of GaNAs and QD has achieved an electron spin polarization of 90% at room temperature [3].

Figure 1(a) shows a schematic of the QD spin-polarized LED. The LED structure including a tunnel-coupled structure of GaNAs quantum well and InGaAs QDs was grown by molecular beam epitaxy on the *p*-GaAs(100) substrate. A MgO tunnel barrier and electrodes consisting of Fe and Au were grown by electron beam deposition. We performed circularly polarized EL measurements at 200 K with different bias voltages. A magnetic field of 5 T is applied perpendicular to the sample plane for perpendicular magnetization orientation of the Fe electrode. Figures 1(b) and 1(c) show the circularly polarized EL spectra and the corresponding circular polarization degree (CPD) at 3.2 V (10 mA) and 4.0 V (30 mA), respectively. The CPD is defined as $(I_{\sigma+} - I_{\sigma-})/(I_{\sigma+} + I_{\sigma-})$, using circularly polarized EL intensities $I_{\sigma\pm}$. When the bias voltage increased from 3.2 V to 4.0 V, the EL intensity increased by one order of magnitude, whereas the CPD values were almost constant. The bias-voltage-independent EL CPD properties can be explained based on the spin filtering effect of GaNAs.

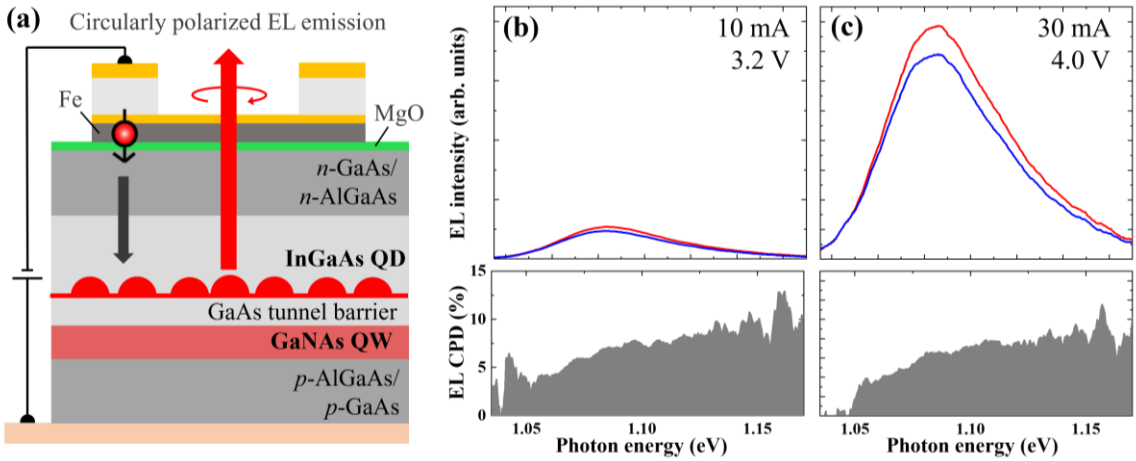


Fig. 1 (a) Schematic image of spin-polarized light-emitting diode using InGaAs QDs tunnel-coupled with a GaNAs quantum well (QW). Circularly polarized EL spectra and corresponding CPD at 200 K with (b) 3.2 V (10 mA) and (c) 4.0 V (30 mA). The magnetic field applied perpendicular to the sample plane is 5 T.

References:

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