Effective suppression of spin relaxation at room temperature in dilute nitride InGaAsN quantum dots

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III-V semiconductor quantum dots (QDs) are expected as active layers of optical spin devices that emit circularly polarized light reflecting electron spin polarization. However, the emission intensity and its circular polarization of QDs significantly decrease at room temperature (RT) due to the electron escape from the QDs and reinjection of spin-depolarized electrons into the QDs. Recently, we found that dilute nitride InGaAsN QDs showed an efficient luminescence at RT. In this study, the circularly polarized luminescence properties of dilute nitride InGaAsN QDs grown at low temperature are investigated, because low temperature growth can introduce spin-filtering defects as with dilute nitride GaNAs. Two types of In0.4Ga0.6As0.98N0.02 QD samples were grown on GaAs(100) substrates by RF-plasma-assisted molecular beam epitaxy, in which the QD growth temperatures were 480°C and 420°C. Circularly polarized photoluminescence (PL) and its time-resolved experiments were conducted at RT. The circular polarization degree (CPD) of QD PL corresponds to electron spin polarization at QD states. The time-averaged CPD increased significantly from 7% for the 480°C-sample to 36% for the 420°C-sample. The time-dependent CPD of the 480°C-sample showed a rapid decay from 30% to 5%, which originated from the spin relaxation in the QDs. In contrast, the 420°C-sample showed a temporally constant CPD of 40%. This result reflects a selective removal of minority spins from the QD states, which indicates an effective suppression of spin relaxation. Therefore, we can conclude that dilute nitride InGaAsN QDs grown at low temperature are promising active layers of spin-polarized light-emitting diodes.