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Bias controlled spin polarization in two dimensional electron and hole gases

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Polarization-resolved magneto-luminescence and magneto-transport measurements have been performed on two-dimensional electron (2DEG) and hole gases (2DHG) in n-type resonant tunneling devices. By varying the applied bias and the laser intensity, it is possible to change significantly the concentration of electrons and holes through the device. Therefore, the optical emission from quantum well (QW) is bias controlled and can comprise neutral and charged excitons, also known as trions. The contact-layer optical emissions comprise indirect transitions from the two-dimensional electron- (2DEG) and hole- gases (2DHG) created next to the barriers. These 2D gases have voltage controlled g-factors and carrier densities. Under high magnetic fields, these 2D gases are usually strongly spin-polarized and can contribute to the polarization of the carriers in the QW by injecting preferentially polarized carriers at different applied biases. The QW circular polarization degree for charged and neutral excitons present higher values, up to -88% at 15T for low bias voltages. The 2DHG-e emission also presents a high negative circular polarization similar to the QW emission indicating that the spin polarization of carriers in the QW could be partially defined by the spin-polarization holes at the accumulation layer which tunnels into the QW. This spin injection seems to be very efficient at lower voltages. However, under higher voltages, other effects probably contribute to the spin polarization of carriers in the QW. Particularly, the 2DEG-h emission is observed after electron resonance and its polarization degree is higher than the QW polarization degree which indicates some spin polarization loss on the tunneling processes probably due to the efficient scattering processes in this voltage region.

[1] Y. Galvão Gobato et al , Appl. Phys. Lett **99**, 233507 (2011).
[2] V. O Gordo et al, Nanoscale Research Lett. **7**, 592 (2012).