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Spin blocking effect in InGaAs/InAlAs double quantum wells due to Rashba spin-orbit coupling

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We report our theoretical proposal of spin-blockade device using an $In_{0.53}Ga_{0.47}As/In_{0.52}Al_{0.48}As$ double quantum well (DQW) structure, where the values of the Rashba spin-orbit parameter α_R are opposite in sign but equal in magnitude between the constituent quantum wells (QW) [1]. Figure 1(a) illustrates the proposed device based on the DQW structure, where each QW (QW1 and QW2), by itself, has an asymmetric confinement potential as shown in Fig. 1(b). Non-magnetic electrodes are attached to the QW1 of the DQW device at both the left and right ends, where the electric current is passed in the x direction. Our theoretical calculations show that the transmission of one spin (e.g., spin-up) component can be blocked by tuning both the channel length of DQW and the magnitude of the externally applied in-plane magnetic field, which enables a spin-polarized current. Our experimental efforts toward realizing the proposed device is also underway [2]. This work was supported by JSPS KAKENHI Grant Number 23360001.

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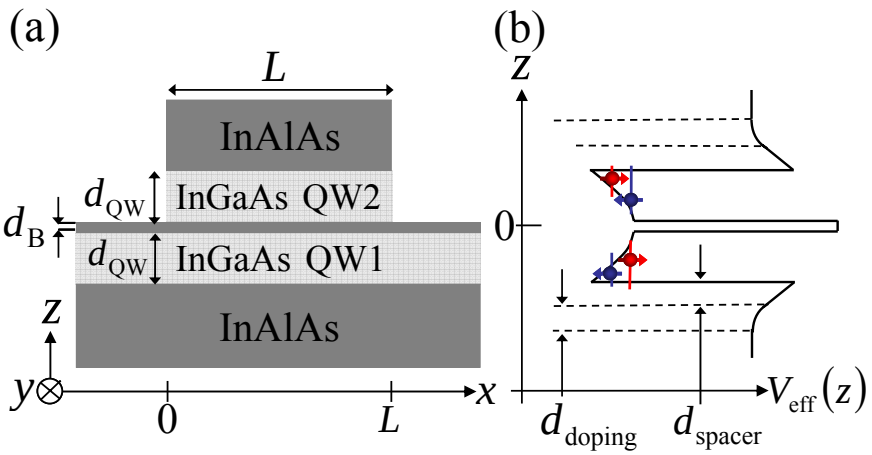

Fig. 1. (a) Schematic illustration of the proposed spin-blocking device made of double quantum well. (b) An example of the effective potential profile in the DQW region for zero magnetic field. Spin-dependent energy eigenvalues for a given wave number **k** are also shown.