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Bias-dependent spin lifetimes in quantum wells

KIMBERLEY HALL, Dalhousie University

The prospect of novel high-performance spin-based semiconductor technologies has lead to new research in spintronics, in which the fields of electronics, photonics, and magnetics merge with the promise of applications in ultra-low-power logic architectures, non-volatile reprogrammable gate arrays, and optoelectronic technologies. Innovation in these areas requires the development of efficient methods for spin manipulation in semiconductor materials. Spintronic device architectures that do not require external magnetic fields or magnetic contacts are especially attractive as they would provide seamless integration with the materials and processing techniques of existing semiconductor devices, while avoiding undesirable stray magnetic fields that may hinder device performance. InAs is an excellent candidate for non-magnetic spintronic device applications due to its strong spin-orbit effects, which lead to gate-controllable pseudomagnetic fields in excess of 1 Tesla.[1] We report the demonstration of room temperature gate control over the electron spin dynamics using the Rashba effect in a (110) InAs/AlSb two-dimensional electron gas. Using the large pseudomagnetic fields in this system, we demonstrate spin manipulation on a picosecond time scale with a low threshold voltage.[1] Our findings are promising for the prospect of nonmagnetic low-power, high-speed spintronics.[2] This research is supported by DARPA MDA972-01-C-0002, DARPA/ARO DAAD19-01-1-0490, NSF ECS 03-22021, and NSERC. [1] K.C. Hall et al., Appl. Phys. Lett. 86, 202114 (2005). [2] K.C. Hall et al., Appl. Phys. Lett. 83, 2937 (2003).