Pulsed electrical injection of phase-coherent spin packets into semiconductors

L. R. Schreiber,[1] C. Schwark,[1] J. Moritz,[1] B. Beschoten,[1*] G. Güntherodt,[1*] M. Lepsa,[2*] C. Adelmann,[3] C. Palmstrøm,[3] and P. Crowell[3]

[1] *2. Physikalisches Institut, RWTH Aachen University, 52056 Aachen, Germany*

[2] *Institute of Bio- and Nanosystems (IBN-1), and [*] Virtual Institute for Spin Electronics (ViSel), Research Centre Jülich GmbH, 52425 Jülich, Germany*

[3] *Department of Chemical Engineering and Material Science, University of Minnesota, Minneapolis 55455, USA*

Abstract :

Spintronics exploits the electron spin and its quantum-mechanical phase for information storage and processing. Future spintronic devices operating with electron spin ensembles require initialization of phase-coherent spin ensembles, reliable phase-coherent manipulation and single-shot read-out. While optical generation was already demonstrated, electrical injection of phase-coherent spin packets remains challenging. Here, we report on the electrical injection of phase-coherent spin packets by ultra-short voltage pulses across an Fe/GaAs Schottky barrier at elevated temperature (25 K). The phase-coherence is proven by multiple Larmor precessions of the spin packets in a transverse magnetic field and probed by time-resolved optical Faraday rotation. Utilizing resonant spin amplification, we investigate the limitation of the phase-coherence by changing the voltage pulse and introduce a simple model for high-frequency spin injection across a Schottky barrier. Our new method and model provide essential aspects for the design of spin-current based phase-sensitive and high-frequency spintronic devices.