Integration of molecular quantum bits with semiconductor spintronics | 9GS	**Start Date:** December 1st 2015
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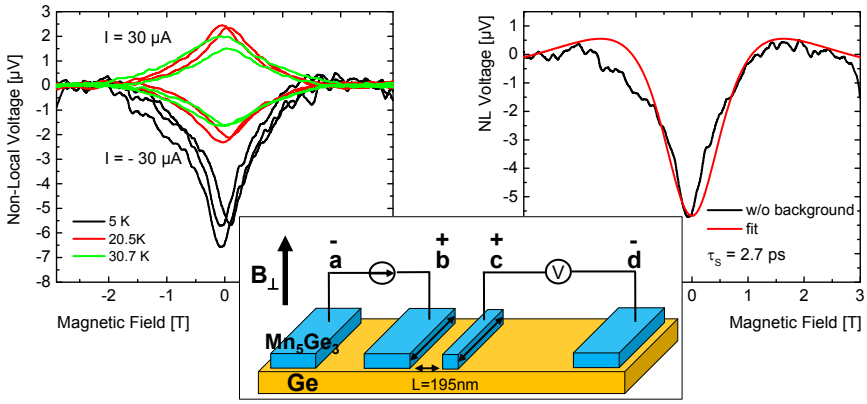
Abstract: This project seeks to integrate novel molecular quantum bits with group IV semiconductor spintronics, thus bridging the gap between (physical) chemistry and electrical engineering. The long term goal is to interface ordered arrays of molecular quantum bits with semiconductor based technology for manipulation and readout purposes. This can not only find applications in quantum computing but also in sensing. Our main objectives are to improve spin injection into semiconductors, to understand, manipulate and exploit the interaction between spin-polarized charge carriers and stationary quantum bits. To this end we have investigated spin injection into semiconductor channels composed of bulk Ge as a high mobility semiconductor and into high mobility Si channels using Mn_5Ge_3 and $Mn_5(SiGe)_3$ electrodes. We have characterized and optimized the process-dependent properties of the ferromagnetic contact material Mn_5Ge_3 leading to atomically sharp boundaries between ferromagnetic electrode and semiconductor channel. Furthermore, we have successfully implemented non-local spin injection schemes into the semiconductor channels and have studied spin polarization lifetimes (see Fig.). In a next step, we will interface the developed, CMOS compatible device with thin layers of molecular quantum bits. Additionally, we have developed a purpose-built Fabry-Pérot resonator for Q-band EPR that will allow in situ coherent microwave manipulation of the molecular quantum bits. As an alternative approach to studying charge carrier-qubit interactions, we are preparing and investigating hybrid materials of conducting polymers and molecular quantum bits (coll. Prof. S. Ludwigs).



Recent results:

- *First demonstration of spin injection into high mobility Si channels showing largest spin depolarization time (16 ns) measured electrically in Si semiconductor devices*
- *Structural and magnetic investigation of Mn_5Ge_3 formation in doped Ge layers*
- *presentation of results at E-MRS Meeting Fall 2017, ECMM 2017*
- *new experimental set-ups for measuring charge carrier polarization lifetimes and for coherent manipulation.*

Publications:

Quantitative prediction of nuclear-spin-diffusion-limited coherence times of molecular quantum bits based on copper(II), S. Lenz, K. Bader, H. Bamberger, J. van Slageren,*, *Chem. Commun.*, **53**, 4477 - 4480 (2017).

Electrical detection of spin transport in Si two-dimensional electron gas systems, L.T. Chang, I.A. Fischer, J. Tang, C.Y. Wang, G. Yu, Y. Fan, K. Murata, T. Nie, M. Oehme, J. Schulze, K.L. Wang Nanotechnology **27** (2016) 365701

Mn_5Ge_3 formation in doped Ge layers, S. Bechler, H. Funk, M. Kern, I. A. Fischer, J. van Slageren, J. Schulze, in preparation

Further Collaborators: Prof.Dr. Sabine Ludwigs (Universität Stuttgart)