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Three-terminal experiments on epitaxial Si/MgO tunnel junctions JULIANE LAURER, MAREEN SCHAEFER, MATTHIAS KRONSEDER, MICHAELA TROTTMANN, MARKUS HAERTINGER, JOSEF ZWECK, CHRISTIAN H. BACK, DIETER WEISS, MARIUSZ CIORGA, DOMINIQUE BOUGEARD, Institut fuer Experimentelle und Angewandte Physik, Universitaet Regensburg, Germany — In the field of spin injection into semiconductors, experiments in a three-terminal (3T) Hanle geometry are widely used to determine spin life times and spin diffusion lengths. However, as charge and spin current are not separated in the 3T geometry, it is yet unclear how reliable 3T experiments are to reveal spin-related quantities of the semiconductor channel. In particular, the impact of defect states in the tunnel barrier or at its interfaces on measured 3T Hanle-like signals has intensely been discussed recently.
In our contribution, we compare 3T experiments on entirely MBE-grown epitaxial Si/MgO/Fe/Au and Si/MgO/Au, i. e. ferromagnetic and nonmagnetic tunnel junctions. Both sample types show a similar Lorentzian signal comparable to those obtained by the Hanle effect of a precessing and dephasing spin ensemble. In contrast to the ferromagnetic sample, the resistance of the nonmagnetic sample increases for increasing external magnetic field. We discuss the dependence of the signal on bias, temperature and orientation of the external magnetic field, taking into account the high crystalline quality of our epitaxial tunnel junctions with atomically sharp interfaces.

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