Development of a semiconductor-superconductor hybrid 2DEG with in-situ Nb.

S. Telkamp[1]*, C. Todt[1], F. Křížek[1,2], M.Hinderlin[2], D. Haxell[2], M. Coraiola[2], E. Cheah[1], R. Schott[1], F. Nichele[2] & W. Wegscheider[1]

*Lead presenter: stelkamp@phys.ethz.ch
1 Advanced Semiconductor Quantum Materials Group, ETH Zurich, Switzerland;
2 IBM Research Europe, Switzerland

The physics of topologically protected states, e.g. Majorana zero-bias modes, has been recently investigated in various semiconductor-superconductor platforms ranging from quasi 1-D nanowires to 2-D electron systems [1][2]. Most of the state of the art experiments rely on MBE-grown InAs combined with in-situ deposited epitaxial Al films [3]. More recently, promising results were shown using other superconductors, e.g. Sn [4], Pb [5] or Nb[6], which offer a larger operating range in temperature and magnetic field. In this project we have developed a new hybrid material combination based on Nb as the superconductor. A novel method is implemented to achieve an epitaxial relationship between an in-situ magnetron sputtered Nb thin film and a shallow InAs 2DEG by using an Al interlayer. We show optimization of the material stack to form the highly transparent interfaces necessary to induce the superconducting gap of the Nb in the InAs heterostructure. Furthermore, STEM analysis of the crystal structure together with transport measurements of Josephson Junctions fabricated from this material will be shown in order to demonstrate its suitability as a platform to investigate topologically protected states.

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