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Supercurrent and Magnetoresistance-Oscillations in Nb/InAs-Nanowire/Nb Josephson junctions — •Haci Yusuf Günel[1], Igor Batov[2], Hilde Hardtdegen[1], Kamil Sladek[1], Andreas Winden[1], Karl Weis[1], Gregor Panaitov[3], Detlev Grützmacher[1], and Thomas Schäpers[1,4] — [1]Peter GrünbergInstitute (PGI-9) and JARA-Fundamentals of Future Information Technology, Forschungszentrum Jülich GmbH, 52425 Jülich, Germany — [2]Institute of Solid State Physics, Russian Academy of Sciences, Chernogolovka, 142432 Moscow district, Russia — [3]Peter GrünbergInstitute (PGI-8) and JARA-Fundamentals of Future Information Technology,Forschungszentrum Jülich GmbH, 52425 Jülich, Germany — [4]II. Physikalisches Institut, RWTH Aachen University, Aachen, Germany

One of the common goals in semiconductor/superconductor hybrid devices is to fabricate Schottky barrier free contacts at the interface of the two materials.[1] The natural formation of an electron accumulation layer on InAs surfaces prohibits the formation of a Schottky barrier. Therefore this material became the most preferred one for semiconducting weak links in Josephson junctions. This unique property of InAs in combination with the bottom-up growth approach of nanowires, led to many interesting experiments, e.g. tunable supercurrent [2] or Cooper pair beam splitters.[3]

In the experiments aluminum (Al) was used as a superconducting material, which has a low critical temperature (T_c) and a low critical magnetic field (B_c). As an alternative, we have used superconducting Niobium (Nb) with a high T_c and B_c that offers the advantage to study Josephson properties in different regimes. In this report, we have used InAs nanowires with two different bulk carrier concentrations, i.e. $\sim 10^{18}\mathrm{cm}^{-3}$ (low doped) and $\sim 10^{19}\mathrm{cm}^{-3}$ (highly doped). The contacting process of Nb electrodes has been realized by standard electron beam lithography.

We systematically investigated the basic Josephson properties, i.e. the effect of temperature, magnetic field and electric field on the supercurrent through the InAs nanowires. By taking advantage of the high T_c ($\sim 9.3K$) of the superconducting Nb, we were able to measure a supercurrent up to 4.0K. The highest critical current $I_c \sim 100$nA has been measured at 0.4K for a junctions with a highly doped InAs nanowire. For low doped nanowire Josephson junctions, a full control of the supercurrent has been achieved by applying a gate bias. We have found a monotonous dependence of the measured critical current in the presence of a perpendicular magnetic field rather than a Fraunhofer-like diffraction pattern. The experimental results have been compared to a recent theoretical model of Ref.[4]. In addition, we studied the supercurrent and conductance fluctuations as a function of gate voltage. Here, a remarkable enhancement of the conductance fluctuation amplitude has been observed. In the last part, we have studied the magnetoresistance-oscillations of Josephson junctions.

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