Aharonov-Bohm and Altshuler-Aronov-Spivak oscillations in quasi-ballistic phase-pure core/shell GaAs/InAs nanowires

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Abstract

Qubit systems based on high quality hybrid superconducting quantum devices are often realized by using semiconductor nanowires. In core/shell GaAs/InAs nanowires, containing a tubular conductor in the InAs shell, the strong confinement near the surface ensures good coupling to a superconductor. We present magnetotransport measurements on zincblende phase-pure GaAs/InAs core/shell nanowires [1], where the reduced disorder compared to polycrystalline nanowires is expected to result in improved transport properties. When an axial magnetic field is applied penetrating the tubular conductor, h/e-periodic Aharonov-Bohm type oscillations are observed in the magnetoconductance [2]. In addition, phase-rigid h/2e-periodic oscillations corresponding to Altshuler-Aronov-Spivak oscillations are observed. By temperature-dependent measurements, we identify a quasi-ballistic transport regime with few scattering centers in the conducting shell, which nevertheless leads to an Altshuler-Aronov-Spivak correction.

References

[1] M. M. Jansen et. al., *ACS Appl. Nano Mater.*, 11 (2020) 11037

[2] O. Gül et. al., Phys. Rev. B, 89 (2014) 5417

Figures

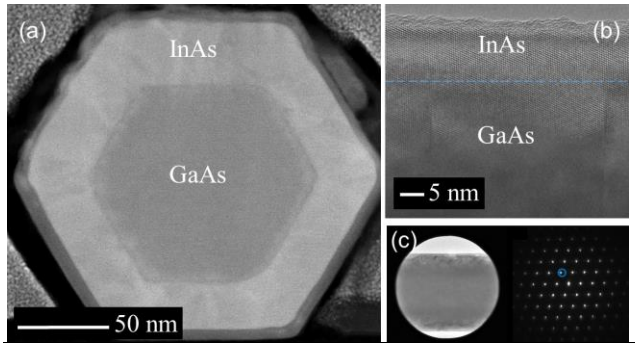

Figure 1: (a), (b) Transmission electron microscopy images of a nanowire cross section and interface, respectively. (c) Interference pattern indicating a zincblende phase.

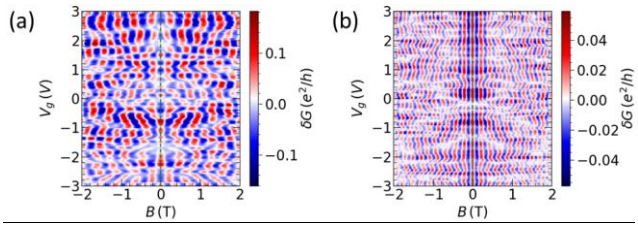

Figure 2: (a) The filtered-out h/e-periodic conductance contribution as a function of axial magnetic field and gate voltage, shows phase shifts along zero magnetic field, as a hallmark of Aharonov-Bohm oscillations. (b) The filtered-out h/2e-periodic contribution reveals a robust phase around zero field as a characteristics of Altshuler-Aronov-Spivak oscillations.

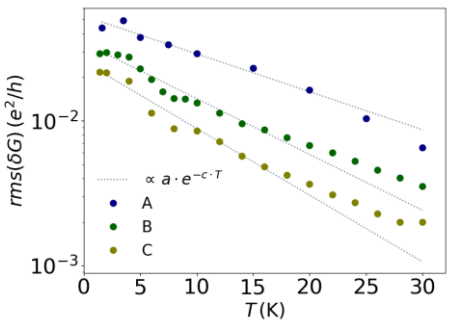

Figure 3: Oscillation amplitude vs. temperature and quasi-ballistic fit for three measured GaAs/InAs core/shell nanowire devices.