Shot noise of a quantum point contact on a two-dimensional hole gas

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Current fluctuation (current noise) is a powerful probe to address details of the fundamental transport properties beyond the conductance. Especially the shot noise, the nonequilibrium current noise, is sensitive to quantum statistics, scattering, and many-body effects [1]. Shot noise measurement at a quantum point contact (QPC) fabricated on two-dimensional electron gas (2DEG) have been performed already by many groups [2,3], where the shot noise suppression below the Poisson value was observed as theoretically predicted. Compared to such conventional QPCs, a QPC fabricated on two-dimensional hole gas (2DHG) has not been fully investigated so far. As holes in 2DHG have larger effective mass and stronger spin-orbit interaction than electrons in 2DEG, it is very interesting to investigate the similarity and dissimilarity between the electron QPC and the hole QPC [4-6].

Here we present shot noise measurements on a hole QPC. To the best of our knowledge, shot noise of hole QPCs has not been explored so far.

The experiment was performed on a QPC fabricated by local anodic oxidation lithography (Fig. 1) on a p-doped GaAs/AlGaAs heterostructure. Conductance and shot noise were measured in a dilution refrigerator with a resonant circuit and a home-made cryogenic amplifier [7].

The QPC shows a clearly quantized plateau at $2e^2/h$ tuned via adjusting a side gate bias voltage below 1 K [5]. In addition, we can see the extra plateau at $0.7(2e^2/h)$, so called 0.7 structures, which remains visible above 1 K. We obtain the Fano factor determined from the shot noise. The Fano factor measured in 1.5 K is observed to be close to zero on a quantized conductance plateau, whose behavior is similar to that of the QPC on 2DEG. However, the shot noise measured at 0.6 and 0.3 K around the 0.7 structure unexpectedly exhibits a peak structure around zero bias, which is reminiscent of the zero-bias conductance anomaly.

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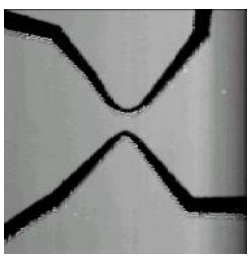

Fig. 1 Photo image of the QPC fabricated by the AFM oxidation technique. The width of the QPC is 200 nm.