Observation of Direct Spin Injection from NiFe into an InAs Nanowire

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Among numerous spintronics device proposals, the spin field effect transistor due to Datta and Das [1] has attracted a lot of attention. Recently, control of the spin orbit (SO) interaction in semiconductor has been proposed to use the Rashba SO and Dresselhaus SO coupling to perform controlled rotations of electron spins, and Datta-Das type spin FET structure is shown to be effective in a condition when Rashba and Dresselhaus effect are matched known as Persistent Spin Helix (PSH) state [2]. However, the relaxation of the spin coherence along the channel is still one of the most important issues for the feasible operation. InAs nanowire is a good candidate for the spin device channel material because Rashba coefficient α and Dresselhaus coefficient β of InAs are both large and comparable. To apply this quasi-1 dimension material, it is necessary to quantify the spin transport properties and control fabrication processes of InAs nanowires grown along [110] directions.

Here we report the local spin injection measurements based on a single InAs nanowire grown by MBE, whose growth orientation is expected to be [110] according to Pd assistance growth mechanism [3]. As shown in Fig. 1, nanowires were dispersed onto an addressed highly doped p-type Si substrate with SiO_2 layer. All of the lithograph patterns were defined by electron beam (EB) lithography and Ti/Au were used as bonding pads, NiFe ferromagnetic electrodes were formed without annealing processes. The relative magnetoresistance (MR) characteristics in two different bias currents at 20K are shown in Fig.2. Assuming the spin diffusion length l_{sd} to be 290nm in an InAs nanowire measured separately [4] and the maximum theoretical l_{sd} to be 10μm [2e], the estimated spin injection efficiency ranged from 20% (l_{sd}=10μm) to 50% (l_{sd}=290nm). It suggests Pd-mediated-VLS-grown InAs nanowires to be a candidate of practical spintronics devices.

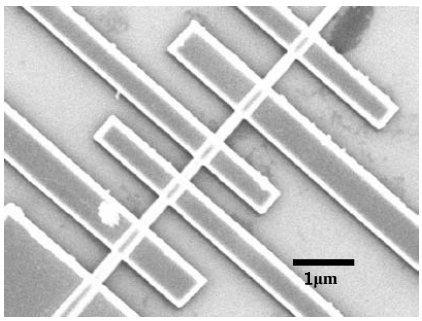

Fig.1 SEM image of spin injection device of an InAs nanowire with FeNi electrodes.

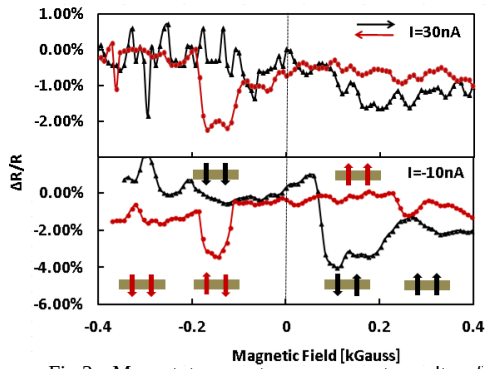

Fig.2 Magnetotransport measurement results of ar InAs nanowire in local set-up.

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