Hybrid Planar Hall Resistance sensor for low magnetic field and spin detection

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1. 서론

Several kinds of magnetic sensor have been used in the past for many applications based on low magnetic field detection such as bio-application[1]. It is in this context that the hybrid AMR-PHR sensor are designed and fabricated to reach the record sensitivities[2]. Thereof combine to the high S/N (signal/noise) ratio have shown the nano-tesla sensitivity and the capacity to detect the room temperature spin switching in nanosized spin cross-over materials[3].

2. 실험방법과 결과

The standard lithography and spurring technologies were used to deposit thin films on the Si wafer. The hybrid sensor structure is based on a multi-ring architecture and trilayer structure Ta/NiFe/Cu/IrMn/Ta (5/10/1.2/10/5nm) respectively. In this case, the soft magnetic layer of NiFe is the sensing material. It is weakly coupled to an antiferromagnetic IrMn layer through a few atomic layers of Cu for thermal stability. The Cu has also function to reduce the shunt current which crosses the antiferromagnetic layer[2].

Two experimental setup were used: For sensitivity investigation and low magnetic field detection, the sensor was polarized by AC current of 1mA along this magnetic easy axis. The external magnetic field was applied in Planar Hall configuration. The sensor response voltage is measured perpendicular to the current direction by a lock-in amplifier. The magnetic field is generated from Helmholtz coil. The operating DC current is applied to the sensor and both AC and DC fields are used for SCO nanoparticles detection experiment.

3. 고찰

The field sensitivity of PHR sensor is deduced from the PHR profile, *ie.*, the voltage versus the magnetic field. In open environment we have measured the step field of about 60nT. The angular dependence of the sensitivity was investigate and shows large different when the applied magnetic field rotate from 0 to 90 degree. The highest sensitivity is observed for the angle of 20 degree between the easy axis and the applied magnetic field direction. This experimental geometry was chosen to detect the SCO nanoparticles.

The nanoparticles consist to the polymetric 1D-chain structure of $[Fe(hptrz)_3]$[4]. In this experiment, a few volume of chloroform suspension of nanoparticle with susceptibility of 4.10^{-4} is directly dropped onto the active surface of the sensor. The PHR sensor detects the magnetic signature of diamagnetic-to-paramagnetic phase transition. The temperature dependence of sensor voltage shows clearly the voltage change associated with the spin transition of nanoparticles. The volume of active nanoparticles was estimated to about 10^{-3} mm^{-3}. The

ultimate challenge is to improve the sensitivity to achieve single particle detection.

4. 결론

The field sensitivity of the ring sensor was increased and allowed us to measure the step field of nanotesla in the open environment. For the first time, the detection of room temperature switching in an SCO nanoparticles using PHR sensor has been observed. The self-balancing of sensor arms resistance and enhanced active area provide us to highlight the concept of novel prototype for SQUID-like magnetometry device with resolution of 10^{-13}emu.

5. 참고문헌

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