Development of a magnetoresistive sensor for fingerprint reading

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Motivation

- Fingerprints are one of the best ways to identify someone
- Current methods of fingerprint collecting rely of cameras to photograph the fingerprints
- By using magnetic sensors additional data can be encoded.

Magnetoresistive sensors

- Anisotropic magnetoresistance (AMR)

  The Magnetoresistance (MR) changes according to the direction of the external field.

- GMR

  Stacks of alternating ferromagnetic and non-magnetic metallic layers.

  The MR changes according to the direction of the magnetization of ferromagnetic layers.

- TMR

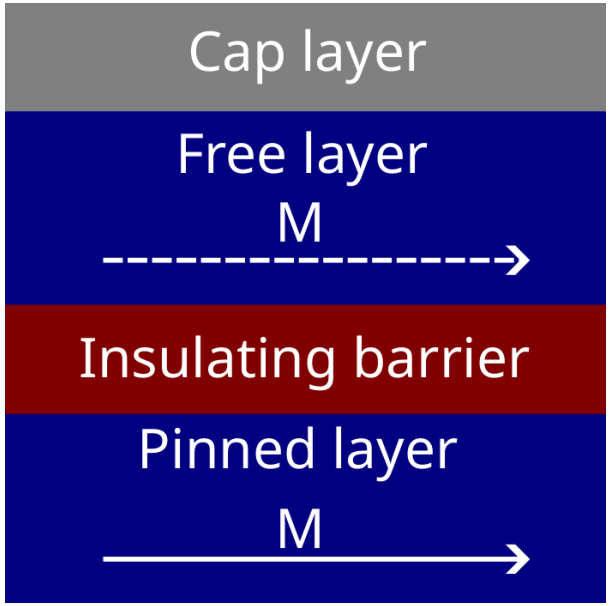
  Stacks of alternating ferromagnetic and isolating layers.

$$\frac{\Delta R}{R} = \frac{R(H) - R(0)}{R(0)}$$

Tunneling magnetoresistance

Conduction electrons overcome the insulating barrier though tunneling.

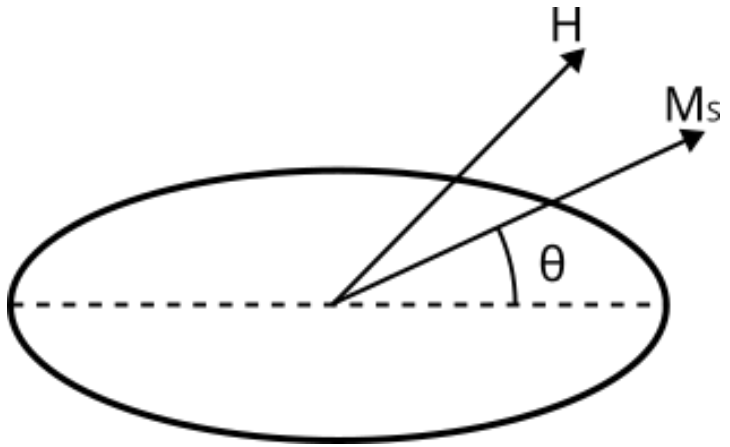
TMR occurs due to the differences in the Up and Down spin channels.



$$TMR = \frac{G_p - G_{ap}}{G_{ap}}$$

Stoner-Wohlfarth Model

Simple but powerful model of magnetic layers.



Calculates the total energy density.

$$E(\theta) = -\mu_0 M_s(H^{\parallel}cos(\theta) + H^{\perp}sin(\theta)) - K_u cos^2(\theta) - \frac{1}{2}\mu_0 M_s H_d cos^2(\theta)$$

Sensing direction

The magnetic ink must be magnetized.

The permanent magnet must not interfere with the MR sensor.

The MR sensor must be sensitive to magnetic fields perpendicular to the permanent magnet