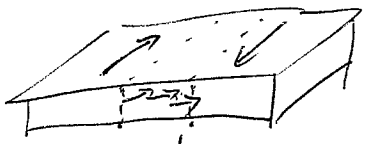
Solution.

1). Demagnetization energy (or magnetic charge density) will be reduced if a multi-domain configuration could be formed.

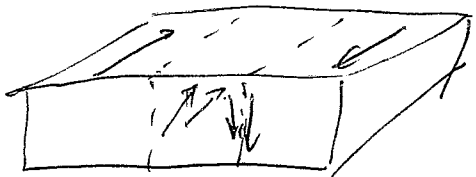
Bloch wall: the spins rotate out of the film plane

Néel wall: the spin rotate in the film plane.

For 5 nm film, Néel wall should be preferred.

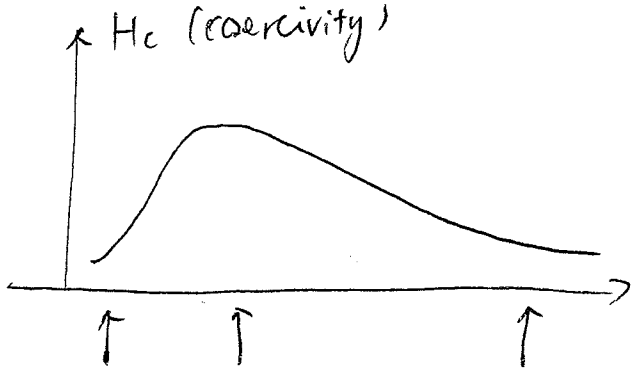


Néel in-plane



Bloch: out-of-plane

2).

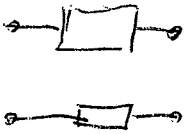


$$\frac{K_u V}{k_B T} = 60 \qquad K_u = \frac{60\, k_B T}{V} = \frac{60 \times 1.38 \times 10^{-16} \times 300}{2 \times 25 \times 10 \times 10^{-21}}$$

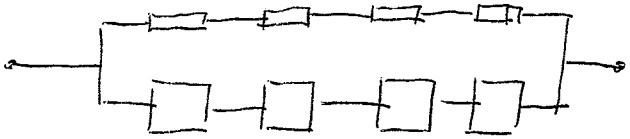
$$= 4.97 \times 10^5 \text{ erg/cm}^3$$

3) Two key aspects for the discovery of GMR
a) spin-dependent scattering
b) antiferromagnetic and ferromagnetic coupling through a non-magnetic layer

Assume R_H for spin opposite to the magnetization direction
R_L for spin parallel to the magnetization direction
$R_H > R_L$.



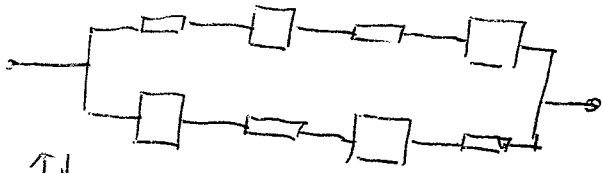
Magnetization parallel configuration;



$R^{\uparrow\uparrow}_{total} = 4R_L // 4R_H$

$R^{\uparrow\uparrow} < R^{\uparrow\downarrow}$

Magnetization anti-parallel.



$R^{\uparrow\downarrow}_{Total} = (2R_L + 2R_H) // (2R_L + 2R_H)$

4). Two approaches (either one is fine)
a). doping B (or N) to make the free layer with fine grains (small) thus the average magnetic anisotropy will be lower.
b) doping Co, Ni to adjust the magnetocrystalline anisotropy directly.

$$H_{ex} = \frac{J}{Mt} = \frac{0.075}{1700 \times 3 \times 10^{-7}} = 140\ (Oe)$$

Two possible approaches to enhance the exchange bias:
a) doping no magnetic or low-magnetization element to lower the net magnetization of fixed layer
b) To improve the surface (interface) roughness for the antiferromagnetic layer, thus enhance J.