**MEGNETORESISTANCE**

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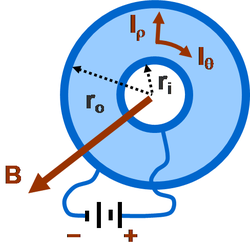
**Abstract**

***Magnetoresistance****is the property of a material to change the value of its*[*electrical resistance*](http://en.wikipedia.org/wiki/Electrical_resistance)*when an external*[*magnetic field*](http://en.wikipedia.org/wiki/Magnetic_field)*is applied to it. The effect was first discovered by*[*William Thomson*](http://en.wikipedia.org/wiki/William_Thomson,_1st_Baron_Kelvin)*(more commonly known as Lord Kelvin) in 1856, but he was unable to lower the electrical resistance of anything by more than 5%. This effect was later called ordinary magnetoresistance (OMR). More recent researchers discovered materials showing* [*colossal magnetoresistance*](http://en.wikipedia.org/wiki/Colossal_magnetoresistance)*(CMR), [giantmagnetoresistance](http://en.wikipedia.org/wiki/Giant_magnetoresistance" \o "Giant magnetoresistance)* *(GMR) and*[*magnetic tunnel effect*](http://en.wikipedia.org/wiki/Magnetic_tunnel_effect)*(TMR).*

**1.introduction.**

William Thomson (or Lord Kelvin) first discovered ordinary magnetoresistance in 1856. He experimented with pieces of iron and discovered that the resistance increases when the current is in the same direction as the magnetic force and decreases when the current is at 90° to the magnetic force. He then did the same experiment with nickel and found that it was affected in the same way but the magnitude of the effect was greater. This effect is referred to as anisotropic magnetoresistance (AMR). **2.The Corbino disc:**

Figure 1 illustrates the Corbino disc. It consists of a conducting annulus with perfectly conducting rims. Without a magnetic field, the battery drives a radial current between the rims. When a magnetic field parallel to the axis of the annulus is applied, a circular component of current flows as well, due to the [Lorentz force](http://en.wikipedia.org/wiki/Lorentz_force). A discussion of the disc is provided by Giuliani. Initial interest in this problem

[](http://en.wikipedia.org/wiki/File:Corbino_disc.PNG)

[http://bits.wikimedia.org/skins-1.18/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Corbino_disc.PNG)

Figure 1: Corbino disc. With the magnetic field turned off, a radial current flows in the conducting annulus due to the battery connected between the (infinite) conductivity rims. When a magnetic field along the axis is turned on, the [Lorentz force](http://en.wikipedia.org/wiki/Lorentz_force)drives a circular component of current, and the resistance between the inner and outer rims goes up. This increase in resistance due to the magnetic field is called *magnetoresistance*.

began with Boltzmann in 1886, and independently was re-examined by Corbino in 1911.

In a simple model, supposing the response to the Lorentz force is the same as for an electric field,

the carrier velocity **v** is given by:

 \mathbf{v} = \mu \left( \mathbf{E} + \mathbf{v \times B} \right), \ 

where μ = carrier mobility. Solving for the velocity, we find:

\mathbf{v} = \frac{ \mu}{1+(\mu B)^2} \left( \mathbf{E} + \mu \mathbf{E \times B} \right), \ 

where the reduction in mobility due to the **B**-field is apparent.

**3.Anisotropic magnetoresistance (AMR).**

AMR is the property of a material in which a dependence of electrical resistance on the angle between the direction of electric current and orientation of magnetic field is observed. The effect is attributed to a larger probability of s-d scattering of electrons in the direction of magnetic field. The net effect is that the electrical resistance has maximum value when the direction of current is parallel to the applied magnetic field. AMR up to 50% has been observed in some ferromagnetic uranium compounds.

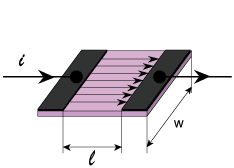
In a [semiconductor](http://en.wikipedia.org/wiki/Semiconductor) with a single carrier type, the magnetoresistance is proportional to (1 + (*μB*)2), where μ is the [semiconductor mobility](http://en.wikipedia.org/wiki/Electron_mobility) (units m2·V−1·s−1 or T−1) and *B* is the magnetic field (units [teslas](http://en.wikipedia.org/wiki/Tesla_(unit)" \o "Tesla (unit))). [Indium antimonide](http://en.wikipedia.org/wiki/Indium_antimonide), an example of a high mobility semiconductor, could have an electron mobility above 4 m2·V−1·s−1 at 300 K. So in a 0.25 T field, for example the magnetoresistance increase would be 100%.

To compensate for the non-linear characteristics and inability to detect the polarity of a magnetic field, a somewhat more complex structure is used for sensors. It consists of stripes of aluminum or gold placed on a thin film of [permalloy](http://en.wikipedia.org/wiki/Permalloy" \o "Permalloy) (a ferromagnetic material exhibiting the AMR effect) inclined at an angle of 45°. This structure forces the current not to flow along the “easy axes” of thin film, but at an

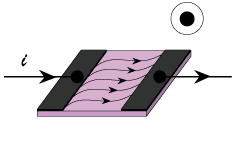
angle of 45°. The dependence of resistance now has a permanent offset which is linear around the null point. Because of its appearance, this sensor type is called '[barber pole](http://en.wikipedia.org/wiki/Barber_pole)'.

The AMR effect is used in a wide array of sensors for measurement of Earth's magnetic field (electronic [compass](http://en.wikipedia.org/wiki/Compass)), for electric current measuring (by measuring the magnetic field created around the conductor), for traffic detection and for linear position and angle sensing. The biggest AMR sensor manufacturers are [Honeywell](http://en.wikipedia.org/wiki/Honeywell), [NXP Semiconductors](http://en.wikipedia.org/wiki/NXP_Semiconductors), and [Sensitec GmbH](http://en.wikipedia.org/w/index.php?title=Sensitec_GmbH&action=edit&redlink=1" \o "Sensitec GmbH (page does not exist)).

**4.How to Calculate the Magnetoresistance Effect.**

**Magnetoresistance Effect Models**

Current mode under non-magnetic field



Current mode under magnetic field

* If magnetic flux (magnetic field) is not applied, the current flows straight through the InSb plate. However, if magnetic flux is applied, a Lorentz force proportional to the magnetic flux density will deflect the current path.
* As the current path is deflected, the current flows through the plate for a longer distance, causing the resistance to be increased.

Lorentz force (F) = qV x B

Q:Electric charge (Coulombs)  
V:Rate vector (m/s)  
B: Magnetic flux density (Wb/m2)

"When charged particles travel through a magnetic flux, a force proportional to the traveling rate and magnetic flux density is applied to the particles in a direction perpendicular to both the rate vector and direction of the magnetic flux."

**References.**

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