PRESENTATION

ON

SPINTRONICS AND ITS APPLICATION

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SPINTRONICS IS A NEW TECHNOLOGY BASED ON ELECTRON’S SPIN

WHAT IS SPIN

• spin is intrinsic property of electronics
• two electronic spin up spin, down spin
• spin interacts with magnetic fields
• in magnetic field they have different energies
• this property can be implemented in modern electronics to build new devices with better performance
PRINCIPLE

- Spintronics is based on the spin of electrons rather than its charge.
- Every electron exist in one of the two states-spin-up and spin-down, with spins either positive half or negative half.
- The two possible spin states represent ‘0’ and ‘1’ in logical operations.
ferromagnetic materials

- Magnetic semiconductor can be made by incorporation of magnetic materials such as Fe, Mn, Co, Cr, V or Ni into nonmagnetic semiconductor materials
  e.g. (Ga:X)As, (In:X)N

- Where X stands for Fe, Mn, Co and other transition element
  These materials:

- Relatively high Curie temperature
- Can be used for spin amplification, injection, filtering etc.
- Possible to integrate onto existing semiconductor electronic device structure
Building an Electron Spin Gate

Just as the planets orbit the Sun with different spins and tilt about their own axis, electrons orbit the atom with a variety of spin directions. At the atomic level, using both classical and quantum mechanics, magnetic fields can orient the spin direction of electrons.

Electron Spin Gate

If electron spin can be measured and controlled by small changes in voltage, an electrically manipulated SPIN GATE can be fabricated. This continuous “tuning” of electron spin enables a switch to operate across a continuum, the way lights can be dimmed by a rheostat, for instance.

As the electron “pool” is displaced along the growth direction by a voltage, the electrons process at different speeds and can be measured and tuned by the voltage level.

Traditional Quantum Well Region

The electron, speed, and orientation depend on the material environment. In traditional quantum well devices (LED’s, integrated lasers) it is difficult to displace the ‘boxed-in’ electrons with a voltage into adjacent layers.

In a Parabolic Quantum Well the layers of GaAs and AlGaAs are grown in a combination that cause the electrons to “pool” in the base region of the parabola. As the voltage is increased, the parabola displaces the electrons continuously through the different materials and alters their spin properties without distortion.

Parabolic Quantum Well

Back Gate (n-GaAs)

Front Gate (Ti-Al)

Voltage
WORKING

- All spintronic devices act according to the simple scheme: The information is stored into spins as a particular spin orientation (up or down).
- The spins, being attached to mobile electrons, carry information in a wire and the information is read at a terminal.
- The basic GMR device is a 3 layer sandwich of magnetic metal with a non-magnetic metal filling.
- A current passes through the layers consisting of spin up and spin down electrons.
The electrons oriented in the same direction as the electron spin in the magnetic layer pass through quite easily while those oriented in the opposite direction are scattered.

If orientation of one of the magnetic layers is changed by the presence of a magnetic field, the device will act as a filter or a spin valve letting through more electrons when spin orientation in the two layers are the same and fewer electrons when spin orientation are oppositely aligned.
The electrical resistance of the device can therefore be changed dramatically.

The above diagram depicts the nature of the spin valve when the two layers are oppositely aligned.
ELECTRONICS VS SPINTRONICS

- One of the main advantage of spintronics over electronics is the magnets tend to stay magnetize which is sparking in the industry an interest for replacing computer’s semiconductor based components with magnetic ones, starting with the RAM.

- With an all-magnetic RAM, it is now possible to have a computer that retains all the information put into it. Most importantly, there will be no ‘boot-up’ waiting period when power is turned on
Another promising feature of spintronics is that it doesn’t require the use of unique and specialized semiconductor, thereby allowing it to work with common metals like Cu, Al, Ag.

Spintronics will use less power than conventional electronics, because the energy needed to change spin is a minute fraction of what is needed to push charge around.
APPLICATIONS

- GMR sensors find a wide range of applications:
- Fast and accurate position and motion sensing of mechanical components in precision engineering and robotics.
- Missile Guidance
- Position and motion sensing in computer video games.
- Automotive sensors for fuel handling system, speed control and navigation etc.
ADVANTAGES OF SPINTRONICS

- can be easily manipulated by external magnetic field
- long coherence or relaxation time
- less power consumption
- powerful quantum computational property
- ability to make device structure which manipulates electron’s charge and spin
- reduce size of device structure
CONCLUSION

With lack of dissipation, spintronics may be the best mechanism for creating ever-smaller devices.

The potential market is enormous, In maybe a 10-year timeframe, spintronics will be on par with electronics.

That's why there's a huge race going on around the world In exploring Spintronics.
THANK YOU

ANY QUERIES