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Spintronics: Types, Approaches, Devices, Uses & Scope



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Spintronics is one of the rising fields for the upcoming generation of nanoelectronics technology to reduce power consumption, enhance memory and processing capacities. In terms of some means, spintronics is just like electronics in various ways. For instance, **In electronics flow or transport of electrons happens for transferring current. The same thing in Spintronics in which the transfer of electrons but with spinning.** That is why spintronics is important in multiple domains. Spintronics is the latest cutting technology so its utilisations are wide in different fields like hospitals and the electrical industry. **The reason behind this, it takes low power, transfers data quickly and stores high data as compared to traditional technologies.** It has reached to till most of the area but it will be possible in future spintronics utilize everywhere there information storage is required.

Read Also: [Semiconductor Electronics](#)

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Key Terms: Spintronics, Spin Polarization, Magnetism, Giant Magnetoresistance Tunnel, Ferromagnetic Material, Nanotechnology

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What is Spintronics? [\[Click Here for Sample Questions\]](#)

Spintronics is known as spin Flextronics and is the study of the intrinsic spin of the electron and its associated magnetic moment in addition to fundamental electronic charge in solid-state.

It is the replacement of traditional electronics. **The word is composed of electronics and spins. It implies the spin transport electronics, assisting in the passing of information.**

For instance, **spin transportation and spin relaxation in metals and semiconductors are necessary for understanding solid-state issues.** These issues include fundamental research glitches and how this technology is implemented in electronic storage technology.

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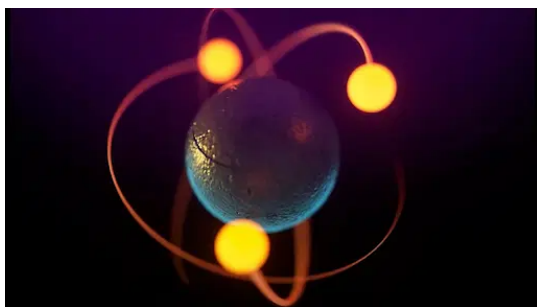
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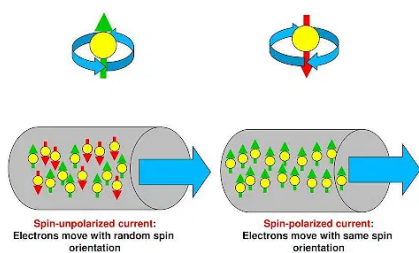


Spintronics

Principle of Spintronics [\[Click Here for Sample Questions\]](#)

Spintronics works on the principle of the spin degree of freedom of electrons and holes which interact with their orbital moments. In this, **magnetic layers as spin polarizers or analysers govern the spin polarization via spin-orbit coupling.** Due to this, the spin current is generated, which is produced by spin **waves**.

What is spintronics? And why?



Principle of Spintronics

Working of Spintronics [\[Click Here for Sample Questions\]](#)

Every electron has two stages, one is spin up and spin down. In other words, electrons rotate either clockwise or anti-clockwise. However, **in the case of ordinary materials, these electrons spin up and down and cancel themselves out. That is why ferromagnetic metal is the best because it has the same aligned spin up in the electrons that are called domains.**

These majority-up and majority-down domains are randomly scattered and with an externally applied magnetic field that will line up the domains in the direction of the electric field.

Approaches of Spintronics [\[Click Here for Sample Questions\]](#)

The spin of electrons is governed by the external magnetic field and polarized electron. It aims to manipulate the magnetism of electrons in semiconductors or metal and render versatility and functionality to the product that will be a rise in future.

Types of Spintronics [\[Click Here for Sample Questions\]](#)

There are two types of Spintronics

• Metal-Based Spintronics

Giant based metal spintronics is the technology behind hard disk storage. A large magnetoresistance tunnel consists of two ferromagnetic plates in which one is fixed and another one is movable, both are divided by a thin insulating layer. When these layers are aligned instead of anti-aligned the electric resistance will be low while flowing spinning electrons.

• Semiconductor Spintronics

Semiconductor spintronics consists of doped semiconductors which show dilute ferromagnetism. It is combined with photonics and magnetics, which give various functional devices such as spin-transistors, spin-LEDs, memory devices and optical switches.

Significance of Spintronics [\[Click Here for Sample Questions\]](#)

Spintronics is a trending research area that has a high potential to generate good results. It renders high power lasers, lower threshold current, high-density logic, low power consumption, wide electronic memory devices, and some optoelectronic devices. **It is an immense source of polarized light.**

• Spin Generation

Let us consider various types to create spin polarization and utilization of spin degrees of freedom in metals and semiconductors. Some of the salient ways are mentioned below.

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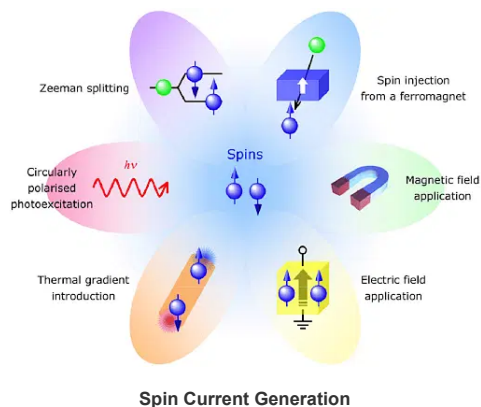
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According to the Seebeck and Nernst effect, a thermal gradient produces spin-polarized carrier flow and this is useful for energy garnering.

Electromagnetic waves and microwaves incite spin-polarized electrons in semiconductors. **A spin-polarized electron generates a current that further flows and extends spin generation. Which includes spin pumping and extreme frequency spin induction.**

Population difference of spin-polarized electrons caused by a magnetic and **electric field**.



Utilization of Spintronics [\[Click Here for Sample Questions\]](#)

Spintronics is a cutting edge technology and has become very popular in a very short period due to its functionality and effectiveness. Due to this, it has wide applications, let us see below.

- This is widely utilized in mass storage devices due to it having the capability to compress maximum data in a small region. For instance, using this technology a single disc of a diameter of 3.5" can store the date of one terabyte.
- It is highly precise for detecting diseases like tumours, bacterial and viral infections. Apart from that, it is used in determining brain **cancer**.
- Spintronics devices are an ancillary tool for digital storage. Hard disk and ram is the perfect example of this.
- Making of Spin Valves and Spin Polarizers semiconductor spintronics with combining conventional technology are in use.
- Spin transistors are regarded to run on electron spin for incorporating a two-state quantum system.
- Spintronics is used in electron spin resonance spectroscopy. That applies in Physics and Chemistry.
- It is applicable in the Chemistry domain as well in nuclear magnetic resonance spectroscopy.
- This can be implemented for judging the electron transport on DeoxyriboNucleic Acid. That would be a remarkable success if we succeeded in doing this.
- Spin based computers apply modern nanofabrication techniques where electron **motion** gets quantized in almost all the directions while conducting electrons are limited to nanometer distance.
- From the implementation of modern nanofabrication techniques, spin-based computers can do electron motion quantized in almost all directions while conducting electrons are limited to nanometer distance.

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Scope of Spintronics [\[Click Here for Sample Questions\]](#)

The future scope of spintronics would be highly demanding but only some scope is discussed below.

- In the creation of low power consuming devices and gadgets.
- Spintronics devices are used in stochastic computing which is a part of unconventional computing.
- Energy harvesting using spin-diodes or spin-caloritronics
- Harvesting of energy with the help of spin diodes and spin-caloritronics by this technology.
- Need for the development of artificial **neurons** and **synapses** based on spintronic devices.
- Spintronics devices are used in the development of synapses and artificial neurons in the human body.

Things to Remember

- As of now usage of spintronics in computer hard disks or magnetoresistive random access memory. In which the electron spin is exploited via the giant magnetoresistance and tunnel magnetoresistance effects. That phenomenon occurs in layered metal structures separated by an absolute insulator.
- Semiconductor devices that work on semi-electronic principle, exploits both spins as well as charge. Those devices can operate much faster than conventional microelectronic devices. This means that which offers new functionality and new cutting edge technology in an electronic storage domain either in computer or any other electronic device.

- There is the most important issue in spintronics is device creation. We need to build such a device that is capable of transporting spin-polarized electrons into and out of the semiconductor and metal region in an effective way. Thus, it is not possible to any leakage and disorders of spin-polarized electrons in any way so that we can serve our purpose from this way.
- As of now in this technology, researchers are using two methods for spin injection and spin detection. The first one is those dilute magnetic semiconductors is deposited onto the surface of conventional semiconductors. Another one is that ferromagnetic metals are deposited onto the surface of semiconductors.

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Sample Questions

- Ques. What is a Spintronic Device? (3 Marks)
- Ques. Why do we prefer Spintronics? (3 Marks)
- Ques. How can we calculate the spin? (3 Marks)
- Ques. What is spintronics used for? (3 Marks)
- Ques. Is spintronics the future? (3 Marks)
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C 2m

D 3m

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3. A constant power is supplied to a rotating disc. The relationship between the angular velocity ω of the disc and number of rotations (n) made by the disc is governed by

CBSE CLASS XII Physics Vectors

A $\omega \propto n^{\frac{1}{3}}$

B $\omega \propto n^{\frac{2}{3}}$

C $\omega \propto n^{\frac{3}{2}}$

D $\omega \propto n^2$

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4. A circular disc is rotating about its own axis. An external opposing torque 0.02 Nm is applied on the disc by which it comes rest in 5 seconds. The initial angular momentum of disc is

CBSE CLASS XII Physics momentum

A $0.1 \text{ kgm}^2 \text{ s}^{-1}$

B $0.04 \text{ kgm}^2 \text{ s}^{-1}$

C $0.025 \text{ kgm}^2 \text{ s}^{-1}$

D $0.01 \text{ kgm}^2 \text{ s}^{-1}$

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5. A convex lens of glass is immersed in water compared to its power in air, its power in water will

CBSE CLASS XII Physics Spherical Mirrors

A increase

B decrease

C not change

D decrease for red light increase for violet light

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6. A circular disc is rotating about its own axis at uniform angular velocity ω . The disc is subjected to uniform angular retardation by which its angular velocity is decreased to $\omega/2$ during 120 rotations. The number of rotations further made by it before coming to rest is

CBSE CLASS XII Physics Uniform circular motion

A 120



B 60

C 40

D 20

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