MAGNETIC SEMICONDUCTORS

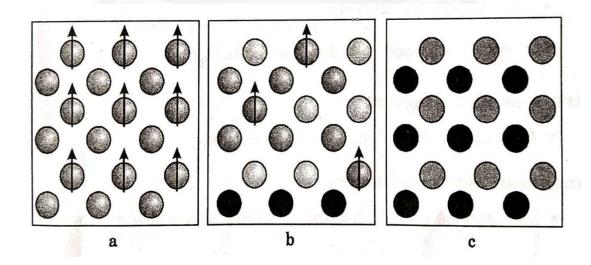
- ➤ **Definition:**Magnetic semiconductors are semiconductor materials that exhibit both ferromagnetism (or a similar response) and useful semiconductor properties.
- ➤ *Example:* Manganese-doped GaAS system, which shows a high Curie temperature upto 200 K.

Importance of Magnetic semiconductors

- ➤ If it is applied in devices, these materials could provide a new type of control of conduction.
- ➤ But, traditional electronics are based on control of charge carriers (*n or p type*).
- ➤ Practical magnetic semiconductors would also allow control of quantum spin state (up or down).
- ➤ This would theoretically provide near-total spin polarization, which is an important property for spintronics.

Dilute magnetic semiconductor (DMS)

- ➤ These are based on traditional semiconductors, but they are doped with transition metals instead of, or in addition to electronically active elements.
- ➤ They are of interest because of their unique spintronics properties with possible technological applications.



Examples for magnetic semiconductors

- 1. Mangenese doped Indium Arsenide and Gallium Arsenide (GaMnAs).
- **2.** Manganese doped Indium Antimonide.
- 3. Zinc Oxide.
- 4. Manganese doped Zinc Oxide.
- 5. n-type Cobalt doped Zinc Oxide.
- **6.** p-type transparent MgO films with cation vacancies.
- 7. Cobalt doped Titanium Dioxide.
- **8.** Iron doped Titanium Dioxide.
- **9.** Chromium doped Titanium Dioxide.
- 10. Copper doped Titanium Dioxide.
- 11. Nickel doped Titanium Dioxide.
- 12. Manganese doped Tin Dioxide.
- **13.**Iron doped Tin Dioxide.
- 14. Strontium doped Tin Dioxide (SrSnO₂).
- 15. Chromium doped Aluminium Nitride.

Applications of magnetic semiconductors

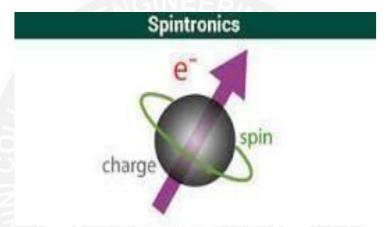
- 1. They are used to make quantum computing architecture using spin polarized electron.
- 2. They are used in magneto optic applications.
- 3. They are used to fabricate spin transistors and spin polarized Light Emitting Diodes (LEDs).
- 4. They are used to exhibit favourable dilute magnetism.

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SPINTRONICS

Spintronics – Spin Based Electronics

- ➤ **Definition:** Study of the intrinsic spin of the electron and its associated magnetic moment, in addition to its fundamental electronic charge, in solid state devices.
- > Spintronics uses electron spins in addition to or in place of the electron charge.
- > The rotational moment creates a small magnetic field.
- ➤ Key concept is controlling the spin of electrons.



➤ Spintronics is intrinsic spin of the electron + its associated magnetic moment + its fundamental electronic charge.

Principle

- > Spintronics is based on the spin of electrons rather than its charge.
- ➤ Every electron exists in one of the two states- spin up and spin down with spins either positive half or negative half.
- ➤ In other words, electrons can rotate either clockwise or anticlockwise around its own axis with constant frequency (as in Figure. 6.22).
- > The two possible spin states represent '0' and '1' in logical operations.

Applications

- 1. Giant magnetoresistance (GMR) in various fields.
- 2. Spin valve.
- 3. Solid state non volatile memories.
- 4. Quantum Information processing and quantum computation.
- 5. Spin based transistors.

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Electonic Devices Vs Spintronic Devices

Sl.	Electronic Devices	Spintronic Devices
No.		
1	Power failure problem	No power failure problem
2	Boot up waitin problem	No Boot up waitin problem
3	More power consumption	Less power consumption
4	Normal speed	Faster speed
5	Cheaper	Costlier
6	Classical property	Quantum Property
7	Less Compact	Mor Compact
8.	Based on properties of charge of	Based on intrinsic property of spin of
	electron	electron

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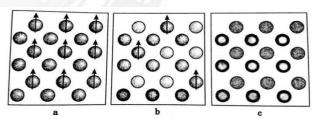


Fig. 5.12 (a) a magnetic semiconductor (e.g. some spinels)
(b) a dilute magnetic semiconductor
(e.g. (GaMn) As, (InMn), P, ZnCoO etc)
(c) a non-magnetic semiconductor
(e.g. GaAs, InP, Cu₂O, NiO etc)

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