MAGNETIC SEMICONDUCTORS

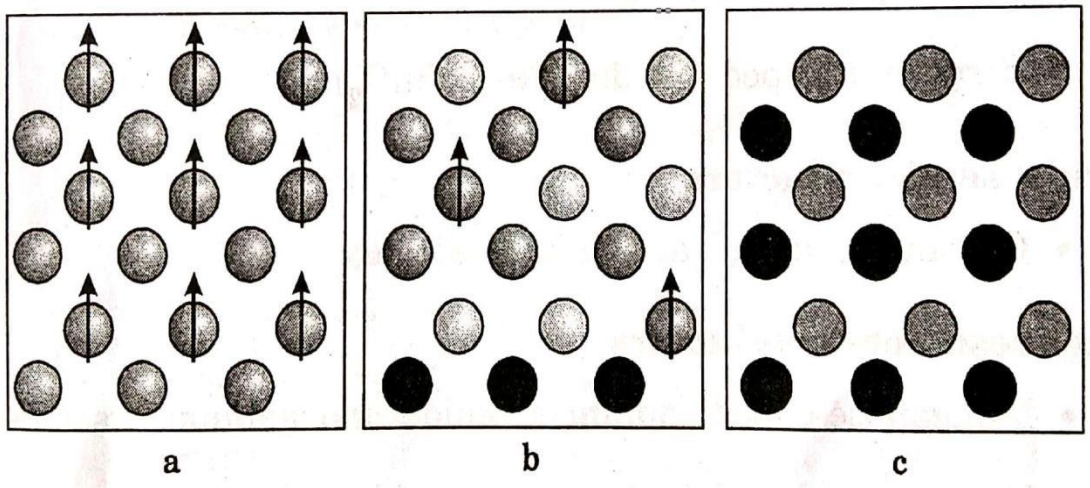
- **Definition:**Magnetic semiconductors are semiconductor materials that exhibit both ferromagnetism (or a similar response) and useful semiconductor properties.
- ***Example:*** Manganese-doped GaAS system,which shows a high Curie temperature upto 200 K.

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 ($SrSnO_2$).
15. Chromium doped Aluminium Nitride.

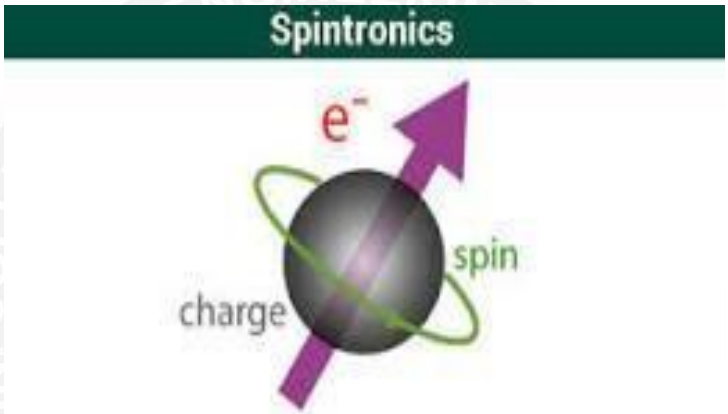
Applications of magnetic semiconductors

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.

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.

Electonic Devices Vs Spintronic Devices

Sl. No.	**Electronic Devices**	**Spintronic Devices**
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 electron	Based on intrinsic property of spin of electron

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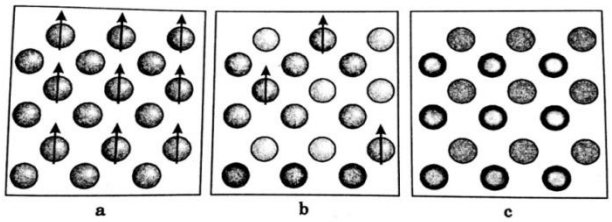

Fig. 5.12 (a) a magnetic semiconductor (e.g. some spinels)
(b) a dilute magnetic semiconductor (e.g. (GaMn) As, (InMn), P, ZnCoO etc)
(c) a non-magnetic semiconductor (e.g. GaAs, InP, Cu_2O, NiO etc)

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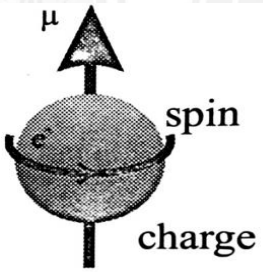

Fig. 6.22
spin of an electron

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