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Synaptic devices based on semiconductor nanocrystals

Key words: Semiconductor nanocrystal; Synaptic devices; Neuromorphic computing

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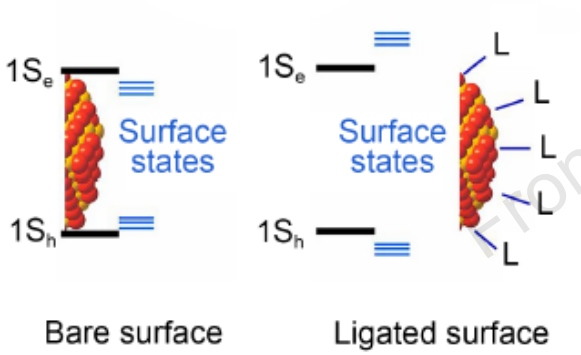
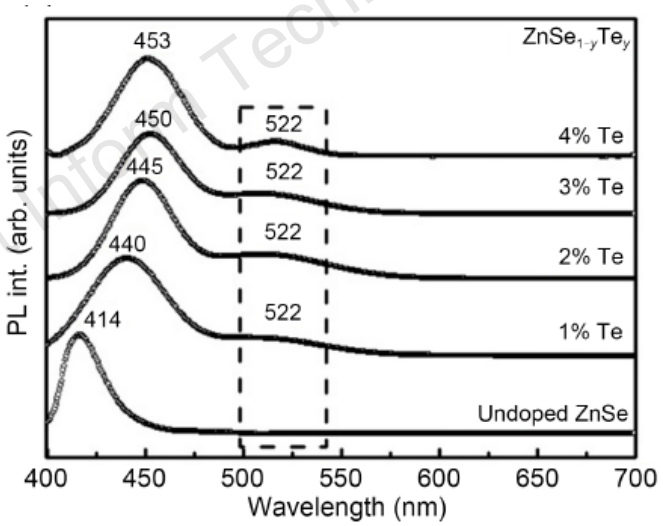
Motivation

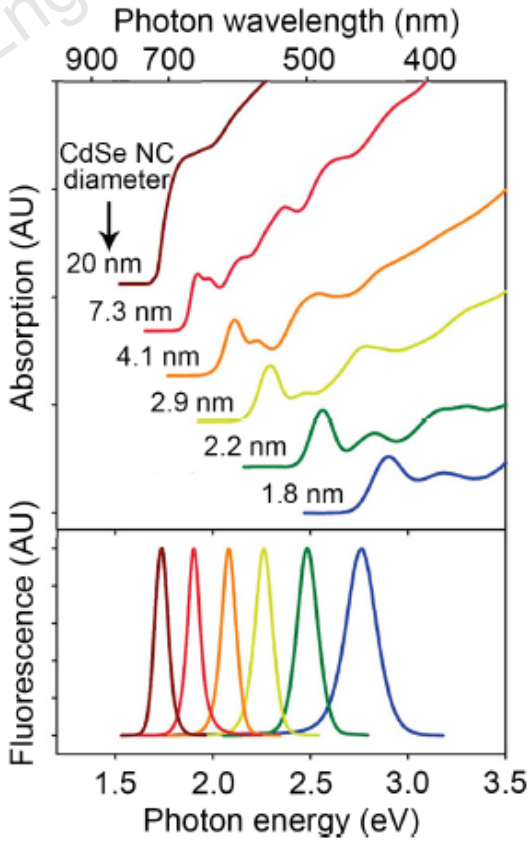
- As one of ideal solutions to current problems faced by traditional computers, synaptic devices have been studied deeply in recent years.
- Semiconductor nanocrystals (NCs) are considered as a preferred material choice for the active layer used in synaptic devices. In addition to Si NCs, transition metal chalcogenide NCs and perovskite NCs are frequently used in synaptic devices. Recent achievements in synaptic devices based on different kinds of semiconductor NCs deserve a detailed summary.

Body

1. Basic properties of semiconductor NCs
   - Size effect
   - Ligand effect
   - Doping effect







Example of ligand effect [1]

Doping effect [2]

Size effect [3]

Body (Cont'd)

2. Synaptic devices based on NC films
   - Synaptic devices based on common NC films
   - Synaptic devices based on core-shell NC films

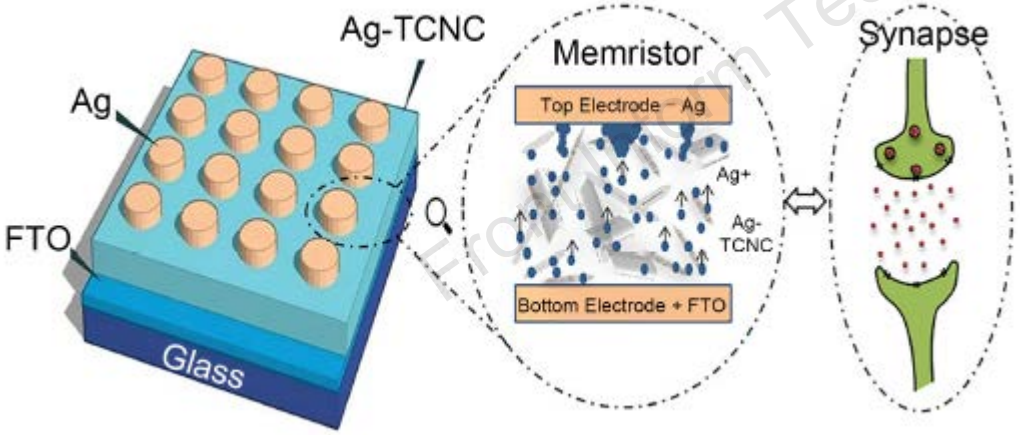


Diagram of synaptic devices based on NC films [4]

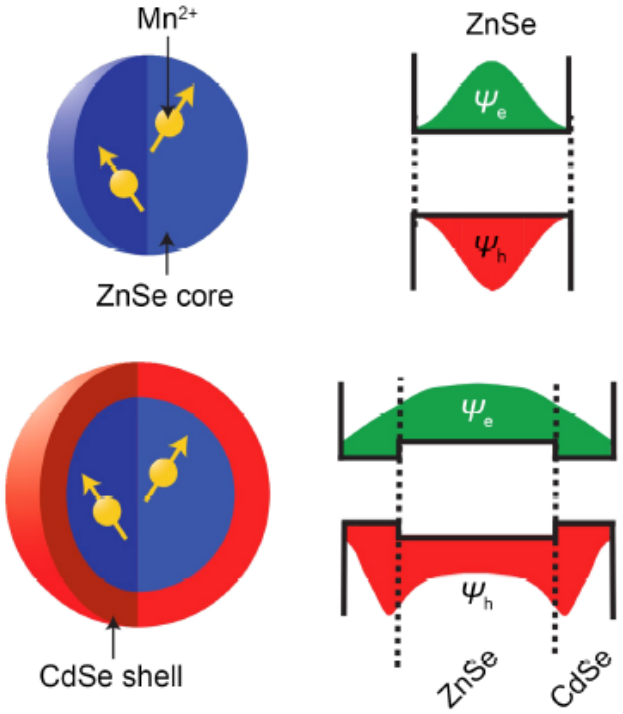


Diagram of core-shell NC [5]

Body (Cont’d)

3. Synaptic devices based on NC heterojunction

- Heterojunction devices of NCs with perovskite
- Heterojunction devices of NCs with organic semiconductors
- Heterojunction devices of NCs with two-dimensional (2D) materials
- Heterojunction devices of NCs with other semiconductor materials

Conclusion

1. The unbalanced development between different types of devices hinders the integrated application of synaptic devices.
2. Reliability problems of devices based on semiconductor NCs will bring risks and dangers to use.
3. The nonuniformity and uncontrollable density of defects in NC solids strongly influence charge transport and trapping.
4. The development of fully optical synaptic devices holds strong potential, but challenges such as wavelength conversion, structure design, and signal attenuation problem remain to be overcome.

References

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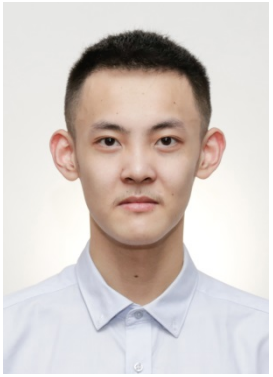

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