SLED

(Spin Light Emitting Diode)

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Contents

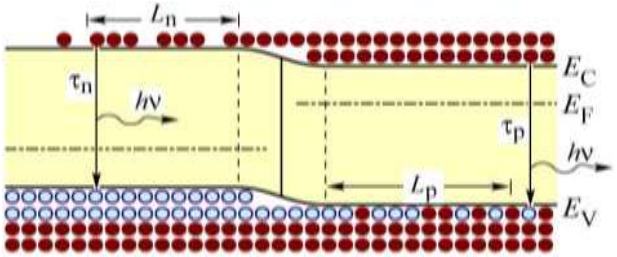
1. History of Light

	Gas & Fuel Lamp	Incandescent Bulb (Light Bulb) 1879~	Fluorescent Lamp 1938~	LED 1962(R), 1993(B), 1997(W)~
Illumination		 T. A. Edison	 G. Inman(GE)	 N. Holonyak(GE)
Information				
	Indirect & Passive			Direct & Active
	• Fuel or Gas • Black body radiation • On / Off • Low Exchange efficiency (fuel → light)	• Electrical Energy (W Filament) • Black body radiation • On / Off • Low Exchange efficiency (Electrical E→ light 10%↓)	• Low Pressure mercury vapor gas discharging • Electric current excite mercury vapor (UV) • Phosphor coated • Several times efficient than bulb	• Semiconductor p-n junctions that under forward bias conditions • Electroluminescence in the UV, visible or infrared regions of the electromagnetic spectrum.

2. Conventional LED

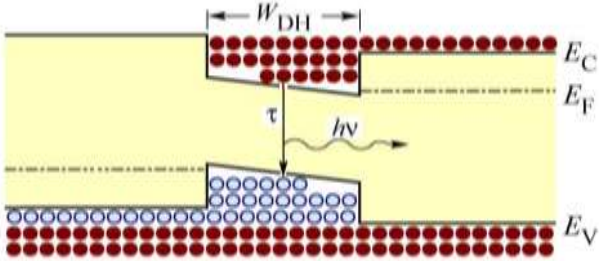
A light-emitting diode (LED) is a p-n junction semiconductor light source. When a forward voltage is applied, electrons are able to recombine with holes within the device, releasing energy in the form of photons
(Electroluminescence is determined by the energy band gap of the semiconductor)

(a) Homojunction under forward bais

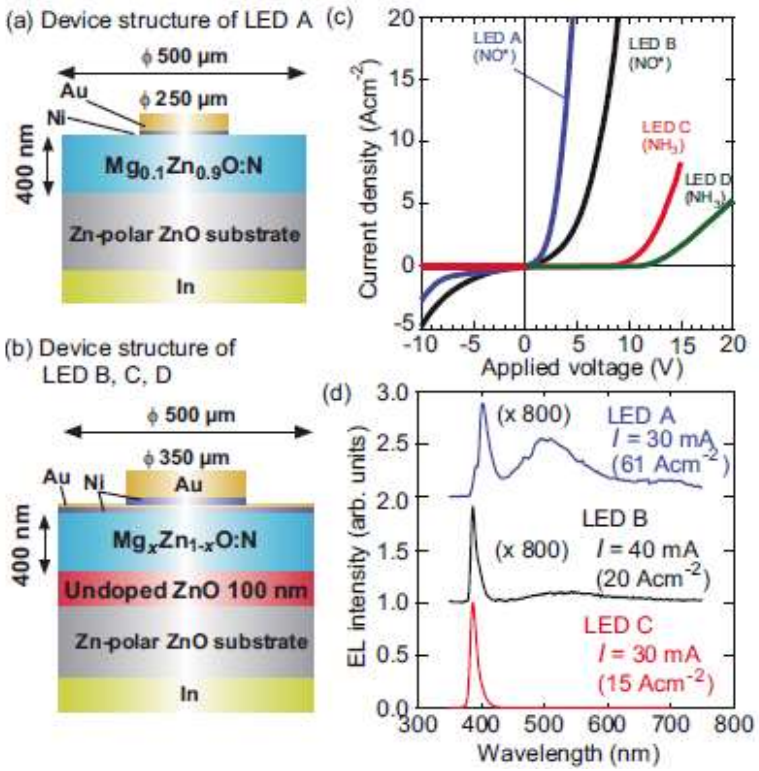


In homojunction, carriers are distributed over the diffusion length

(b) Heterojunction under forward bais



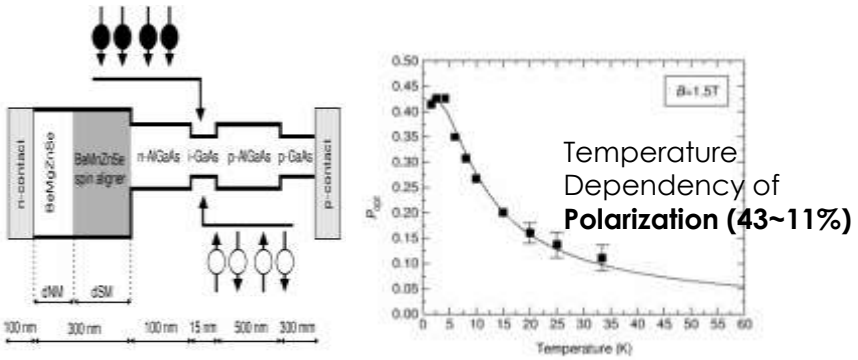
In heterojunction, carriers are confined to the well region



3. What is a SLED_Magnetic semiconductor contact

In the initial research, Paramagnetic & ferromagnetic semiconductor compound are used as a spin injection and align layer But there are some disadvantage in their spin device (external high magnetic field, low temperature operation)

(a) Using Paramagnetic semiconductor ($Be_xMn_yZn_{1-x--y}Se$)

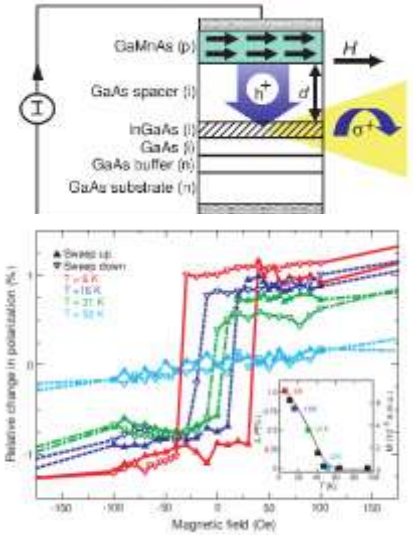


Temperature Dependency of **Polarization (43~11%)**

Utilized the giant g factor of the **paramagnetic** II-VI semiconductor **$Be_xMn_yZn_{1-x--y}Se$** to align the electron spin orientation obtaining an injection **efficiency of 90%**

[R. Fiederling, Nature, V402, 787-789(1999)]

(b) Using Ferromagnetic semiconductor $Ga_xMn_{1-x}As$



Spin polarized light (circular polarization)

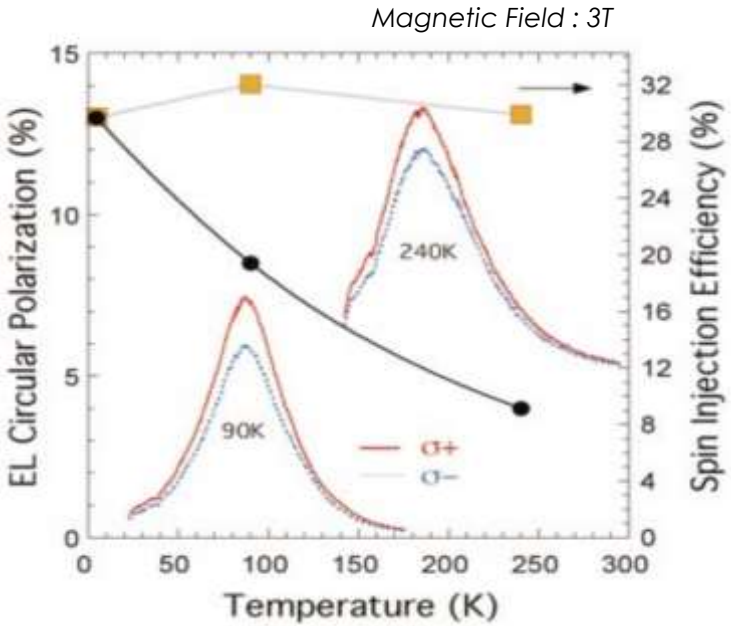
Hysteretic electroluminescence
Temperature dependent
: Polarization rate : ~1%(T : 6~52L)

Ferromagnetic semiconductor **$Ga_xMn_{1-x}As$** as a spin aligner and realized spin injection into GaAs with and **efficiency of the order of 1%**

[Y. Ohno, Nature, V402, 790-792(1999)]

3. What is a SLED_Ferromagnetic metal contacts

Spin injection from a ferromagnetic metal contact into a semiconductor light emitting diode structure (Schottky barrier formed at the Fe/AlGaAs)



Temperature dependence of Polarization$_{circle}$

After correction for unrelated spin relaxation in Ga/As QW

Corresponding spin injection efficiency

- **Advantage**
  - ✓ Ferromagnetic metals are as attractive as spin injection contacts because they offer high temp. and a high level of material development
- **Disadvantage**
  - ✓ Low injection rate of spin polarized carriers (large mismatch in conductivities)

	Spin injection rate(%)		Polarization(%)
	Corresponding	After correction	-
90K	32%	32%	8.5%
240K	**8.5%**	**30%**	**4%**

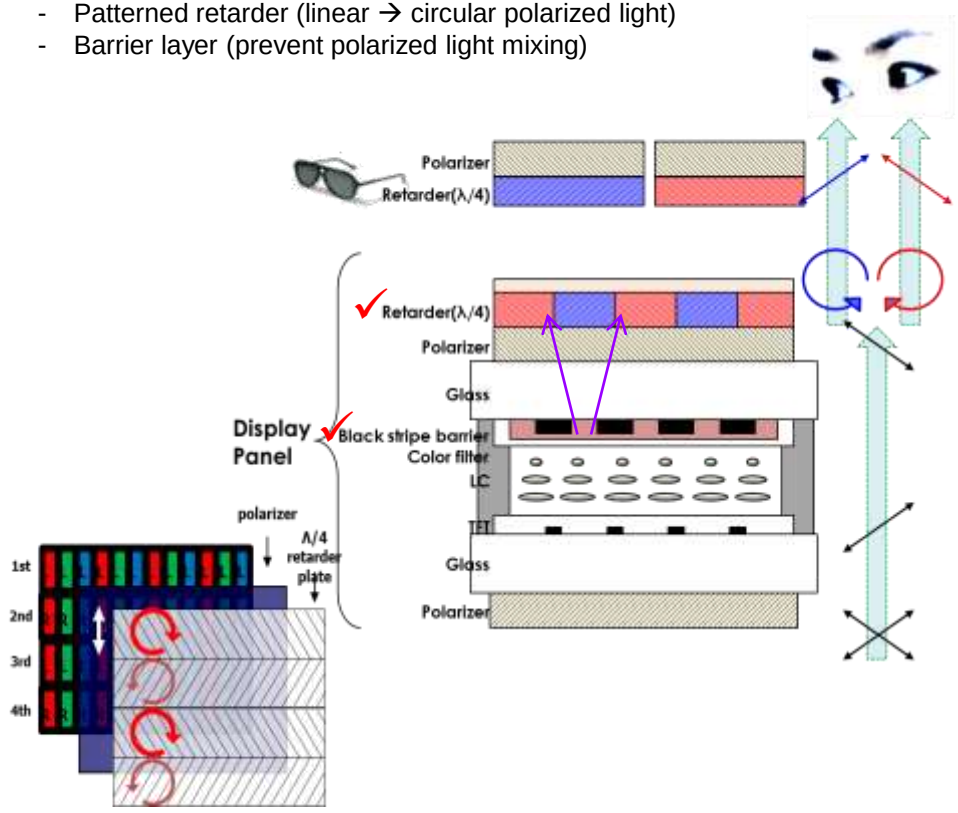
Electron spin relaxation in QW itself more rapidly increased with increasing Temperature

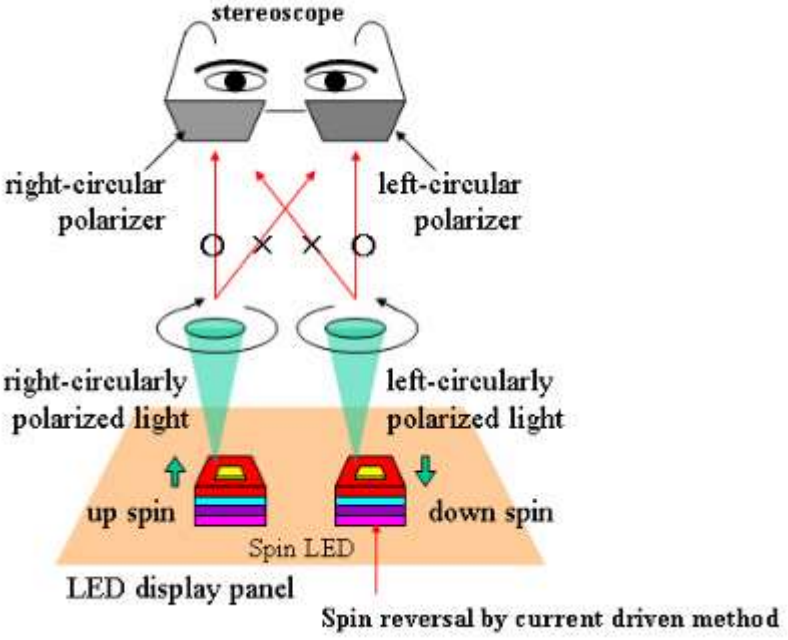
[A. T. Handicki, Applied Physics Letters (2002), 80, 7, 1240-1242]

4. Application of SLED in 3D

- If these new concepts are realized,
  - ✓ Retarder film-less 3D (low cost and Thin panel),
  - ✓ Barrier-less or minimize (high resolution, High transmittance)

Key component in FPR 3D Display,
- Patterned retarder (linear → circular polarized light)
- Barrier layer (prevent polarized light mixing)





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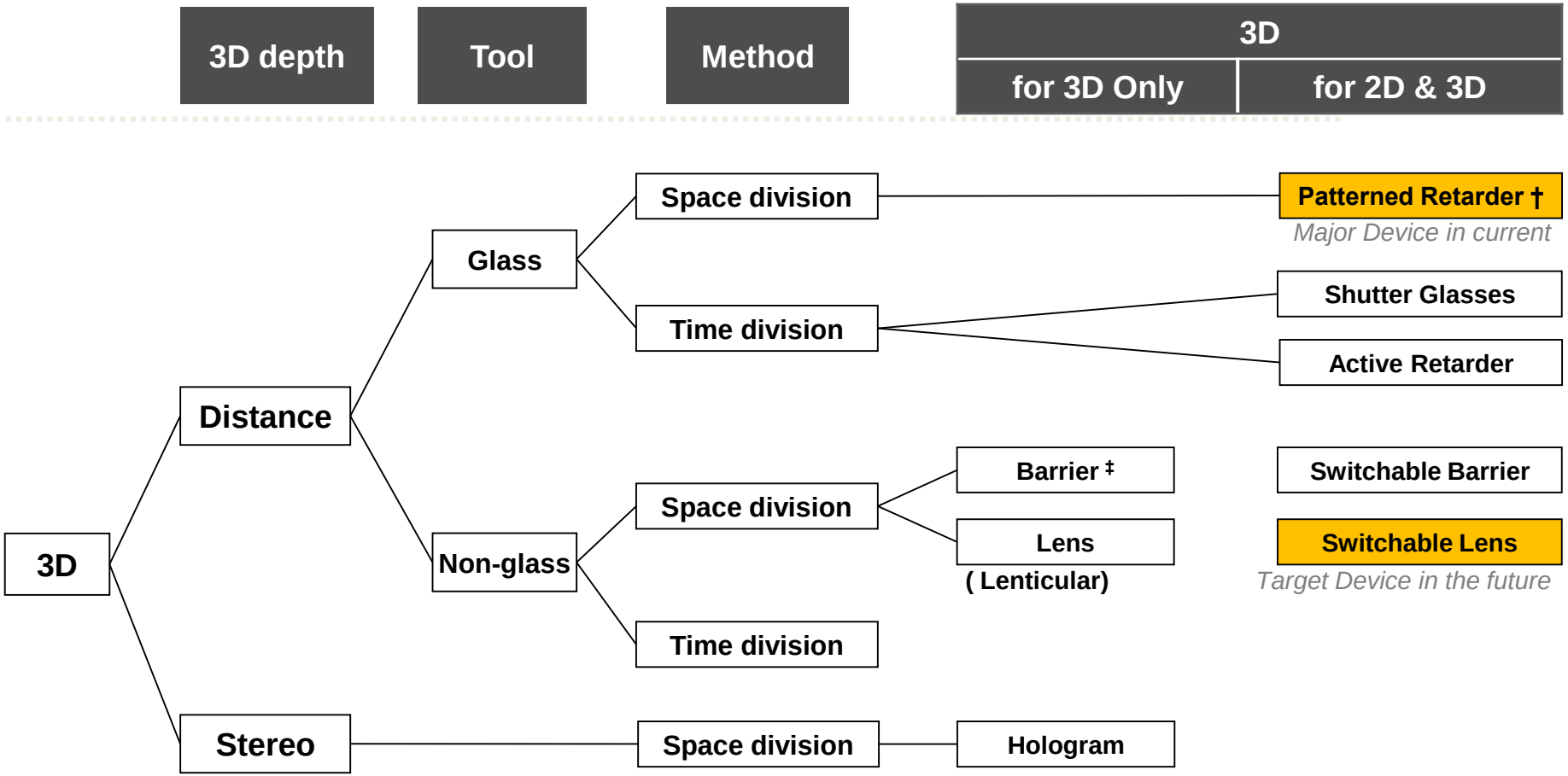
Conclusion

1. **Various idea is needed to apply the spin-LED to commercialized application**
   - ✓ **Enhancing the spin injection ratio to semiconductor**
   - ✓ **High polarization ratio**
   - ✓ **Room temperature operation and less temperature dependency (>RT)**

2. **Especially, In case of display applications**
   - ✓ **Spin-LED could be apply normal LCD as a LED BLU with a λ/4 plate.**
   - ✓ **Spin-OLED is much effective for spin LED display application.**

App. Classification of 3D



App. Visible light communication

Property		VLC	RF
	Bandwidth	Unlimited, 400nm~700nm	Regulatory, BW Limited
	EMI	No	High
	Line of Sight	Yes	No
	Standard	IG-VLC	Yes
	Hazard	No	Yes (H_2O reaction to 2.4GHz)
Mobile To Mobile	Visibility (Security)	Yes	No
	Power Consumption	Relative low	Medium
	Distance	Short	Medium
	Power Budget	Tight	Medium
Infra to Mobile	Security	Yes	No
	Infra	LED Illumination	Access Point
	Mobility	Limited	Yes
	Coverage (Distance)	Short (~10m)	Wide (Short ~ Long Range)