



Enhancement of electroluminescence of $\text{Si}_x\text{C}_y\text{O}_{1-x-y}$ MOSLED

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Outline

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Introduction

- **We want to improve ITO film conductivity.**
- **Ag film have very well conductivity, and Ag film is translucent when film thickness is lower than 20nm.**
- **We are going to investigate the influence of Ag layer sandwiched between ITO films on the EL intensity of MOSLED.**

Experiments

Experiments

- The $\text{Si}_x\text{C}_y\text{O}_{1-x-y}$ films are deposited onto $\langle 100 \rangle$ p-type silicon substrate by radio-frequency reactive magnetron sputtering using SiC target.
- ITO film is deposited onto $\text{Si}_x\text{C}_y\text{O}_{1-x-y}$ as top electrode and Ag thin films are deposited onto ITO film by DC sputtering using Ag target.
- Al layer is grown onto p-type Si substrate as bottom electrode of the MOSLED.

Experiments

- **Four types of ITO/Ag/ITO multi-layers thickness is 55nm/10nm/55nm, 50nm/20nm/50nm, 45nm/30nm/45nm and 40nm/40nm/40nm, respectively.**
- **We have performed Hall measurement and transmittance measurement.**
- **Finally, we compared EL of four type simple.**

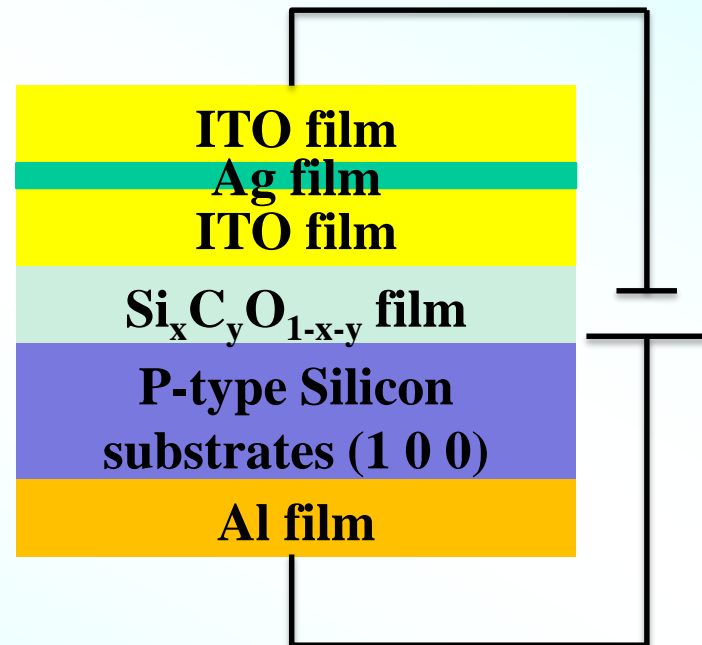
Experiments

$\text{Si}_x\text{C}_y\text{O}_{1-x-y}$ film: Active layer

ITO/Ag/ITO multi-layers : Top electrode

Al film: Bottom electrode

Radio-Frequency reactive Radio-Frequency reactive DC sputtering	
Power	100 W
Speed	60 r.p.m.
Ar	5 sccm
Pressure	15 mTorr
Thickness	300nm
temperature	700 °C
Thickness	200 nm



Results and discussion

Hell measurement

ITO/Ag/ITO

$\text{Si}_x\text{C}_y\text{O}_{1-x-y}$ film: Active layer

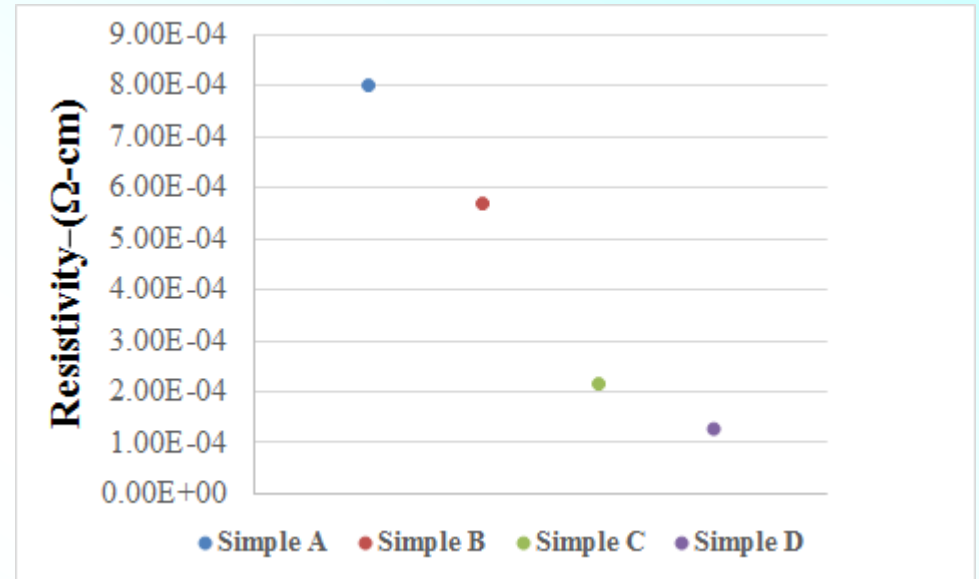
ITO/Ag/ITO multi-layers : Top electrode

Al film: Bottom electrode

ITO/Ag/ITO multi-layers is deposited onto $\text{Si}_x\text{C}_y\text{O}_{1-x-y}$ as top electrode and is then **annealed at 550°C**.

The thicker the Ag film, the lower the film resistivity.

Hell Measurement



SAMPLE	Multi-layer Thickness(nm)	Resistivity (Ω-cm)
A	55/10/55	8.008E-04
B	50/20/50	5.674E-04
C	45/30/45	2.137E-04
D	40/40/40	1.272E-04
ITO	ITO Film 120 nm	7.044E-03

Preparation of MOSLED

ITO/Ag/ITO

$\text{Si}_x\text{C}_y\text{O}_{1-x-y}$ film: Active layer

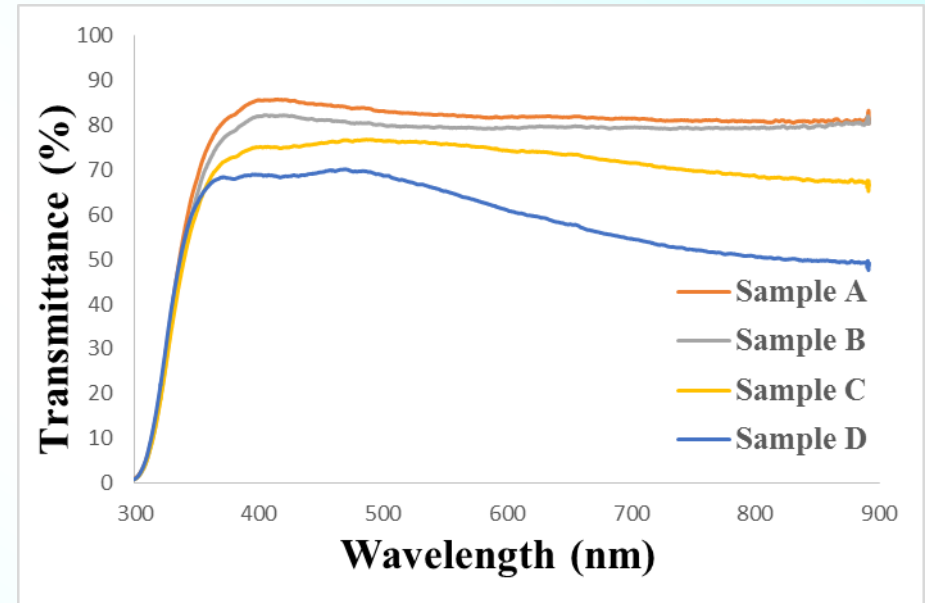
ITO/Ag/ITO multi-layers : Top electrode

Al film: Bottom electrode

For sample A and B, the **transmittance** is higher than **80%** in the visible range.

Ag thin films can **improved resistivity**, and **the transmittance is higher**.

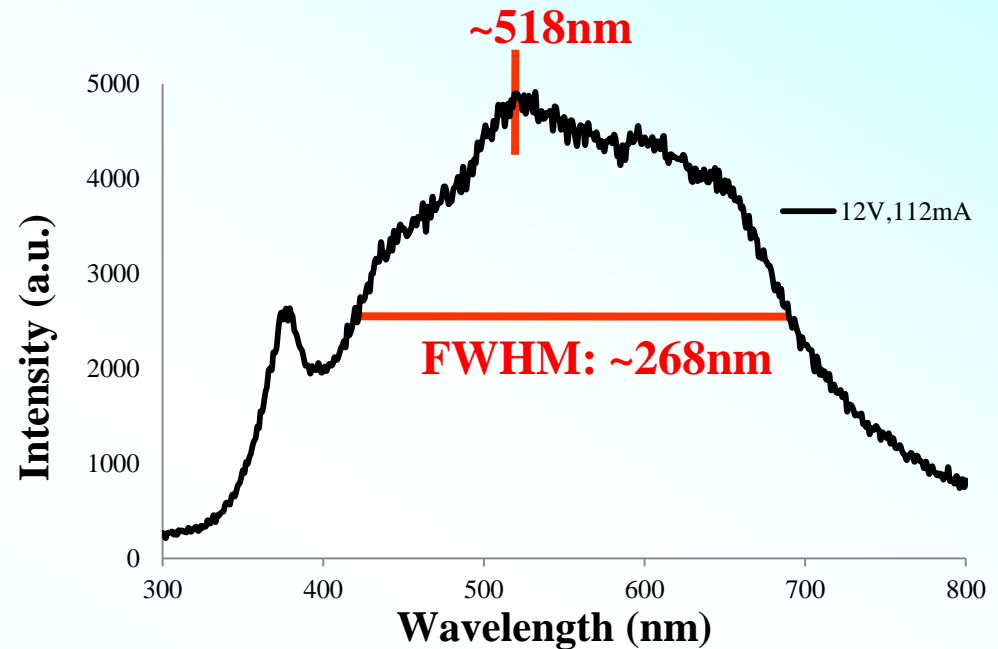
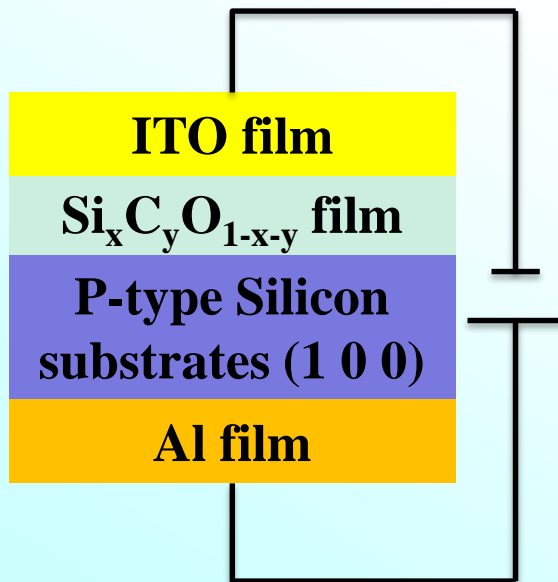
Transmittance Measurement



Electroluminescence measurement

Annealed at 700°C

The 700 °C annealed film shows an EL band centered at ~520 nm and FWHM of ~300 nm. The light color is close to yellow-white.

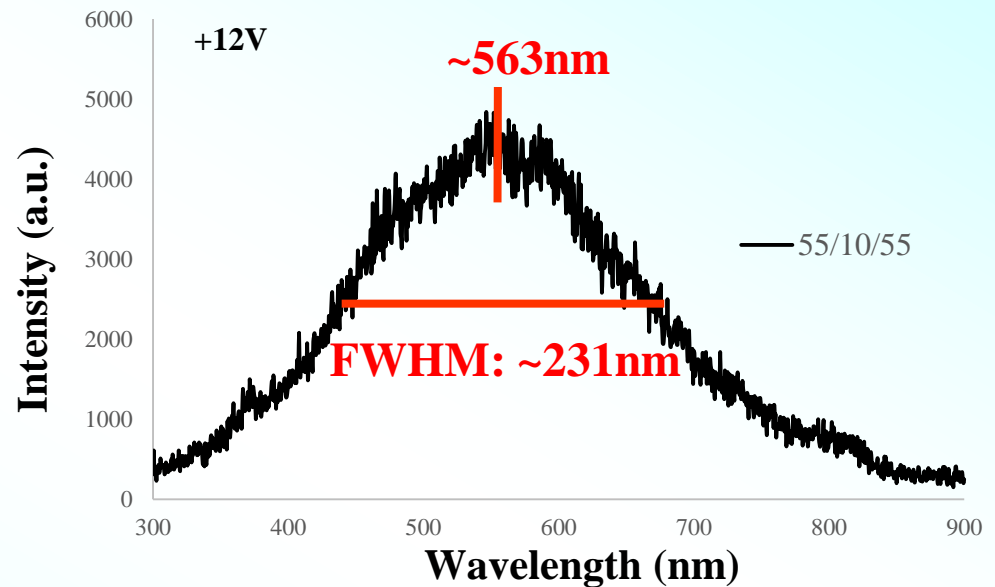
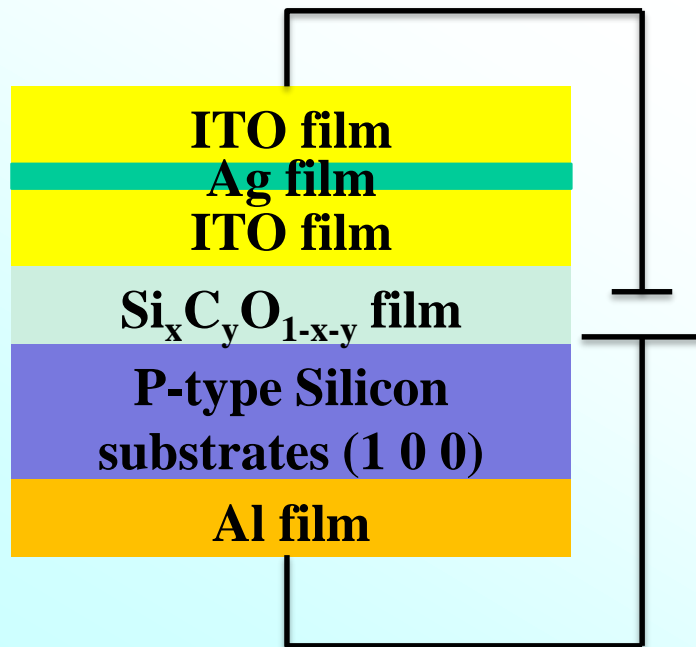


The light is observable by naked eyes in dark field when the applied voltage is greater than +12 V.

ITO/Ag/ITO multilayer

Simple A

Simple A shows an EL band centered at **~563 nm** and **FWHM of ~231 nm**.



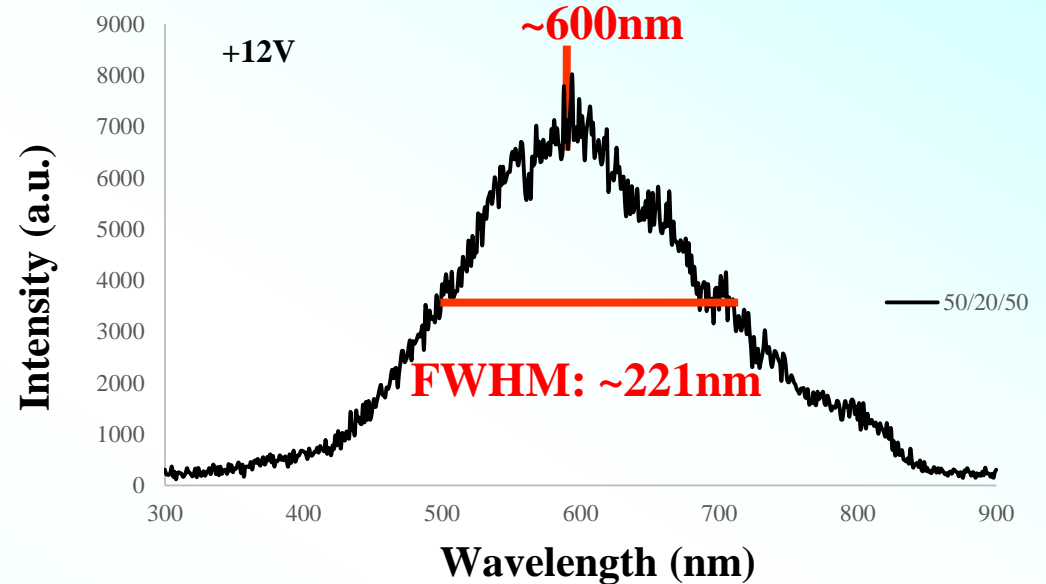
The EL intensity is the same as the as-grown film, but the FWHM is smaller than the as-grown film.

ITO/Ag/ITO multilayer

Simple B
Annealed at 700°C

The EL band of simple B is **centered at ~600 nm** with a **FWHM of ~221 nm**.

The EL intensity is **improved at 3000 a.u.** when Ag thin film thickness is greater than **20 nm**.

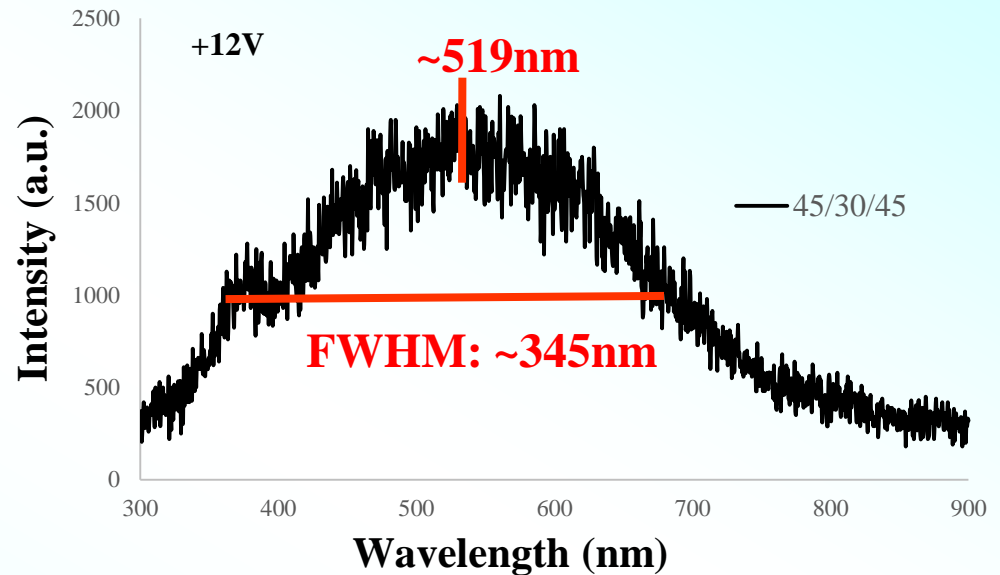


ITO/Ag/ITO multilayer

Simple C
Annealed at 700°C

The EL band of simple C is centered at **~519 nm** with a **FWHM of ~345 nm**.

The emission intensity is **very low**. We only observe few light points in dark field.



Conclusions

- **Ag thin film successfully improved conductivity with as-grown ITO film.**
- **ITO/Ag/ITO multi-layer thickness is controlled to 50nm/20nm/50nm have good conductivity and transmittance.**
- **Our results indicate that the EL intensity is well of simple B.**

Reference

- [1] Zhongyuan Ma, Minyi Yan, Xiaofan Jiang, Huafeng Yang, Guoyin Xia, Xiaodong Ni, Tao Ling, Wei Li, Ling Xu, Kunji Chen, Xinfan Huang, and Duan Feng, *Applied Physics*, vol 101, 013106 (2012).
- [2] K.H. Choia, J.Y. Kima, Y.S. Leeb, H.J. Kima, *Thin Solid Films*, 341, pp.152~155 (1999).

Thanks for your attention