Extended Abstracts of the 1998 International Conference on Solid State Devices and Materials, Hiroshima, 1998, pp. 240-241

Electroluminescent Properties of $Zn_xMg_{1-x}S$:Mn Thin Films

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1. Introduction

$Zn_xMg_{1-x}S$ and $Zn_xMg_{1-x}S$:Mn ternary compound is suitable for the short wavelength optoelectronic application such as laser diodes and electroluminescent displays in the green to ultraviolet region of the spectrum. We have clarified solid solubility of the $Zn_xMg_{1-x}S$ ternary solid solutions[1, 2]. Immediately after our report, electroluminescence of $Zn_xMg_{1-x}S$:Mn thin films has been reported in which blue shift of Mn emission has been described[3, 4, 5]. We have studied fundamental luminescent properties including composition dependence of photoluminescence[6, 7, 8, 9, 10].

In this paper, for the first time we have described photoluminescent properties of $Zn_xMg_{1-x}S$:Mn ternary compound and application to $Zn_xMg_{1-x}S$:Mn thin film electroluminescence(TFEL) device.

2. Experimental

$Zn_xMg_{1-x}S$:Mn thin films have been deposited on a quartz glass substrate by a conventional diode-type rf sputtering system. Mixtures of ZnS+Mn powder and Mg metal have been used as targets. The details of the deposition procedure has already been reported[11, 12]. $Zn_xMg_{1-x}S$:Mn TFEL devices with a conventional double-insulating structure have been fabricated.

3. Experimental Results and Discussion

The PL and PLE spectra have been investigated. Fig.1 shows the composition dependence of the dominant PLE peak energy and the peak energy of the Mn^{2+} emission[13] for the $Zn_xMg_{1-x}S$:Mn(0.5mol%) thin films. The PLE peak energy is assignable to the band gap possibly with excitonic effect. Therefore the excitonic band gap energy of the $Zn_xMg_{1-x}S$ can be described by the relation; $E_g(x)=4.9-1.16x$. Also the Zn composition, x, dependence of the Mn^{2+} emission peak energy is shown by the relation; $E_{Mn}(x)=2.25-0.15x$(eV). The peak energy of Mn^{2+} emission is linearly approximated by the composition x, hence Mn^{2+} emission peak shift may be caused by the intrinsic nature of the host materials.

Fig.2 shows electroluminescence spectra

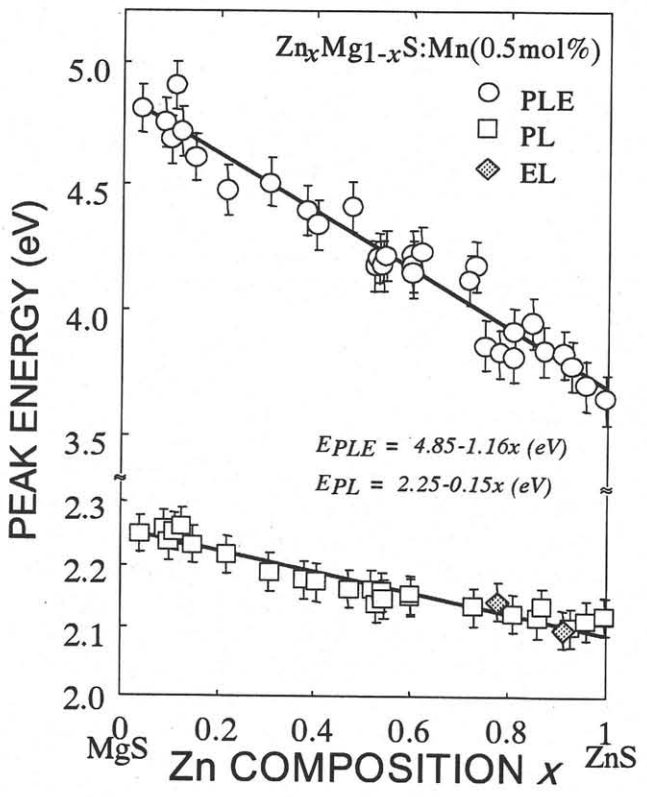

Fig. 1 Composition dependence of PL, PLE and EL Peak Energy.

from EL devices with ITO/Si_3N_4/$Zn_xMg_{1-x}S$:Mn/Si_3N_4/Al structures. EL emission has showed blue peak shift with the increase of Mg composition[3].

In Fig.1 are also shown composition dependence of EL peak energy in addition to PL results. PL and EL peak energy seem to show similar tendency with the increase of Mg composition.

We have observed electroluminescence spectra of $Zn_xMg_{1-x}S$ TFEL devices prepared by radio frequency sputtering for the first time.

4. Conclusion

In summary, photoluminescence and electroluminescence properties have been described for $Zn_xMg_{1-x}S$:Mn with the composition x covering whole range ($0 \leqq x \leqq 1$) by employing radio frequency sputtering. Remarkable dependence of Mn^{2+} emission in $Zn_xMg_{1-x}S$ on the composition has been elucidated. $Zn_xMg_{1-x}S$:Mn TFEL is promising as pure green emitting devices.

Acknowledgments

The authors wish to thank Research Institute of Technology, Tottori Prefecture for EDX measurements. They are grateful to professor Shosaku Tanaka of Tottori University for helpful discussion and valuable comments. This work has been supported in part by the " Research for the Future " program(No.96R12501) of Japan Society for the Promotion of Science(JSPS).

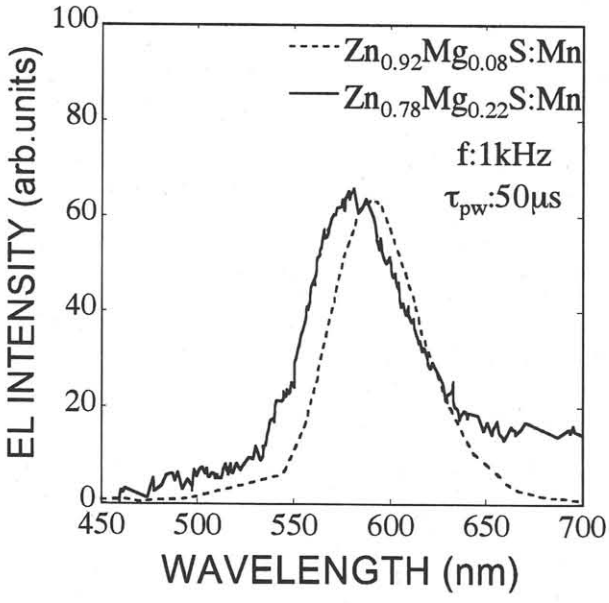

Fig. 2 Emission spectra of $Zn_xMg_{1-x}S$:Mn thin film EL devices

References

[1]H. Kimijima, M. Kitagawa, R. Inoue, N. Shiraishi, M. Hoashi, K. Ichino and H. Kobayashi, The Book of Abstract, 8th Int. Conf. Solid Films and Surfaces, Osaka(July, 1996)112.

[2]H. Kimijima, M. Kitagawa, R. Inoue, N. Shiraishi, M. Hoashi, K. Ichino and H. Kobayashi, Applied Surface Science **113/114** (1997)432-435.

[3]A. Mikami, I. Yashima, F. Kajikawa, Inorganic and Organic Electroluminescence, EL 96, Belrin, (August, 1996)369.

[4]A. Mikami, 1997 SID Int. Symp., Digest of Technical Papers, SID, BOSTON (1997)34.

[5]I. Washizuka and A. Mikami, Proc. 4th Int. Display Workshops(IDW) (1997)pp.601-604.

[6]R. Inoue, M. Kitagawa, T. Nishigaki, K. Ichino, H. Kobayashi, M. Ohishi and H. Saito, Proceedings of Eighth International Conference on II-VI compounds, Grenoble France(1997).

[7]R. Inoue, M. Kitagawa, T. Nishigaki, K. Ichino, H. Kobayashi, M. Ohishi and H. Saito, J. Crystal Growth **184/185**(1998)1076-1080.

[8]R. Inoue, M. Kitagawa, T. Nishigaki, K. Ichino, H. Kobayashi, M. Ohishi and H. Saito, 11th International Conference on Ternary & Multinary Compounds, Salford United Kingdom(1997), Book of Abstract, P2.115.

[9]R. Inoue, M. Kitagawa, T. Nishigaki, K. Ichino, H. Kobayashi, M. Ohishi and H. Saito, Inst. Phys. Conf. Ser. No.152(1998)p.389.

[10]R. Inoue, M. Kitagawa, T. Nishigaki, K. Ichino, Koutoku Ohmi, Syousaku Tanaka and H. Kobayashi, Proc. 4th Int. Display Workshops(IDW) (1997)pp.681-684.

[11]S. T. Lee, M. Kitagawa, R. Suzukawa, K. Ichino and H. Kobayashi, J. Crystal Growth **159**(1995)339.

[12]M. Kitagawa, S.T. Lee, K. Ichino and H. Kobayashi, J. Crystal Growth **159**(1996)205.

[13]J. W. Allen, J. Phys. C : Solid State Phys. **19**(1986)6287.