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# OPTICAL STUDY OF METAL THIN AL FILM - GLASS CAVITY SURFACE-EMITTING AT ROOM TEMPERATURE FOR MICROLASER

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## ABSTRACT

Sharp NIR emission ~ (925) nm of wavelength with ~ 4nm band width was recorded from microcavity(MI)" glass of 0.5 mm in thickness coated thin AL film of 123 nm in thickness". Optical study of this cavity was carried out using Ar+ ion Laser (514.5nm) at room temperature. The metal thin AL film was prepared by DC plasma sputter deposition using argon gas. A large increase in the emission intensity from that cavity was observed with increasing the excitation power from 0.6 to 0.9 watt.

**KEYWORDS:** Luminescence, Metallic Films, Nanoparticles, AL Optical Properties and Glass Optical Properties

## INTRODUCTION

These metal-cavity microlasers provide a great potential for next generation massively parallel optical interconnects without crosstalk among laser elements [1]. Thin films nanoparticles with size in the nanometer region are of great interest because of their optical properties that could potentially be exploited in optoelectronic devices [2]. Photoluminescence (PL) has been used as a common characterization tool and has appeared in many publications [3, 4]. In this work, we have demonstrated the simple design of micocavity(MI) "Metal Thin AL film – Glass" for surface-emitting in NIR spectrum region~ (925) nm. It is working at room-temperature with CW operation. This cavity was examined its emission by homemade set up experiment of excitation laser source Ar+ ion Laser (514.5nm) at room temperature. The cavity MI properties are guided light emission with increasing in intensity according to incident laser power. The cavity showed good thermal stability due to metal coating to Glass substrate

### Experimental Results

Continuous wave set up experiment technique using Ar+ laser (514.5nm) was designed to record and study the NIR emission of (MI) "" glass of 0.5 mm in thickness coated thin AL film of 123 nm in thickness" at room temperature as shown in figure 1

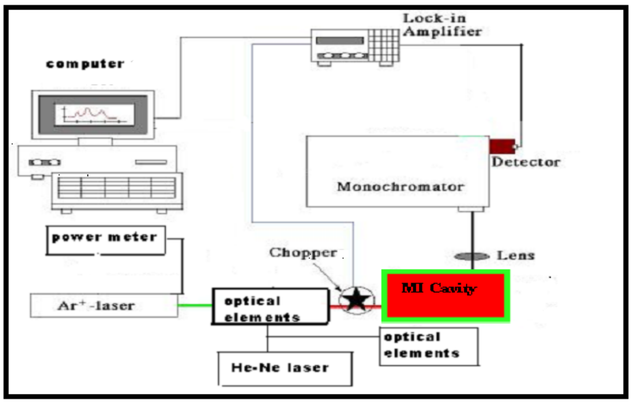


**Figure 1: Set up Experiment for MI Cavity**

NIR emissions intensities were recorded at different excitation power levels with suitable excited angle of sample related to laser beam as shown in figure 2.

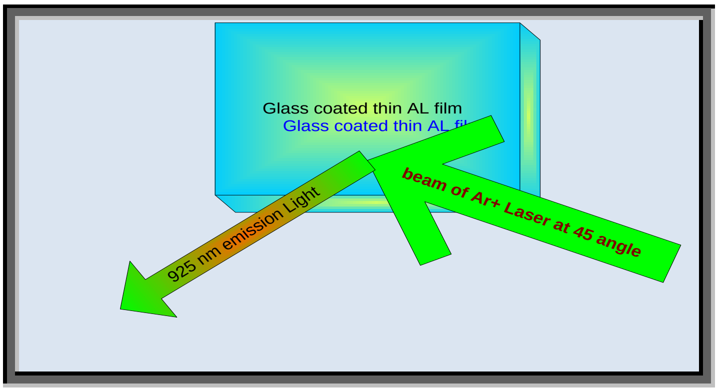


**Figure 2: Suitable Incident Angle of Ar+ Laser Beam at Room Temperature**

The metal thin AL film was prepared by DC plasma sputter deposition using argon gas. A large increase in the emission intensity from MI cavity was observed with increasing the excitation power from 0.6 to 0.9 watt as shown in figure 3. In this study; the Glass substrate offers better optical emission management in comparison to others materials, good absorber to Ar+ Laser beam as shown in figure 4 comparing with optical constant of AL as shown in figure 5. We calculated optical constant of AL using a technical computing language Matlab in order to understanding the effect of optical constant on NIR emission of MI according to energy of excitation source in region of absorption and emission which support the coupling of spontaneous emission into the lasing mode.

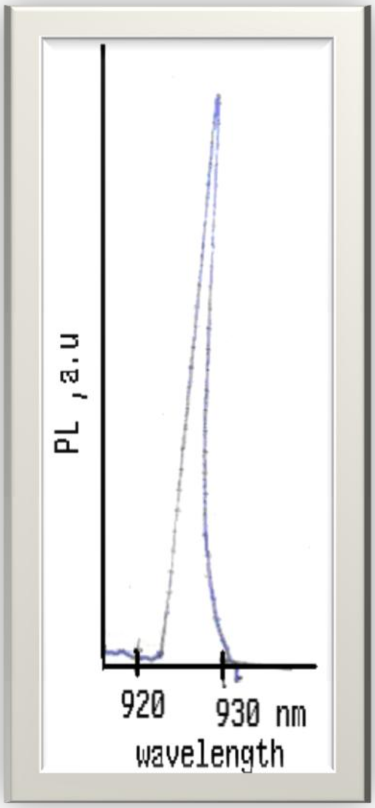


**Figure 3: Strong NIR Emission from MI Cavity was Observed with Increasing the Excitation Power from 0.6 to 0.9 Watt**

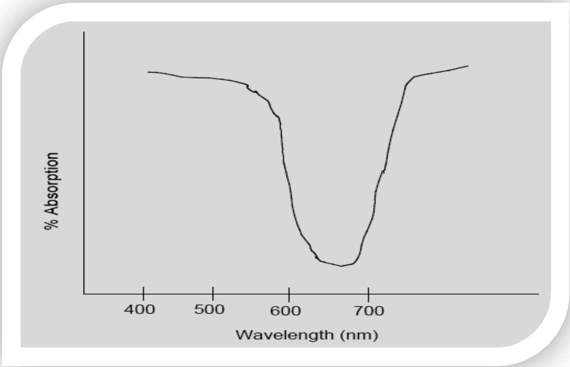


**Figure 4: Glass is Good Absorber to Green Light**

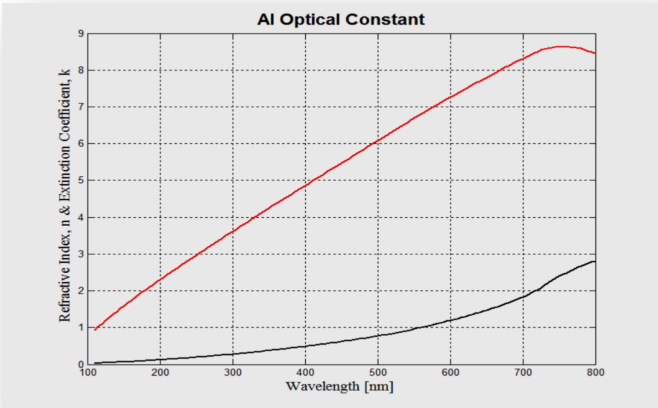


**Figure 5: Optical Constant of AL**

## DISCUSSIONS AND CONCLUSIONS

From this study, we have found from our results that Metal cavities offer better thermal management in comparison to dielectric cavities and are more suitable for electrical pumping or optical pumping. The cavity showed good thermal stability due to metal coating to Glass substrate.

However, existing metal-based nanolasers require high threshold pump power because of the significant absorption loss of the metals at optical frequencies for that we have used 0.6-0.9 watt to obtain NIR emission. In summary, the miniaturization of laser cavities either by dielectric or metallic structures faces two challenges: one mode scalability meaning that as the cavity size decreases, it may no longer support a lasing mode. Another challenge is the fact that as the size of the cavity shrinks [5]. The coupling of spontaneous emission into the lasing mode gives increasing in emission intensity with increasing of incident optical pumping power. Ultimately, the threshold constraint can be completely eliminated by reaching so-called thresholdless lasing, which occurs when every photon emitted by the gain medium is funneled into the lasing mode.

Here we present a validation of the above approach by reporting the first demonstration of lasing action in metal thin AL film based Glass substrate at room temperature in NIR of E.M spectrum using simple set up experiment.

## REFERENCES

1. Chien-Yao Lu, Shu-Wei Chang, Shun Lien Chuang, a_ Tim D. Germann, and Dieter Bimberg" Metal-cavity surface-emitting microlaser at room temperature" APPLIED PHYSICS LETTERS 96, 251101(2010).
2. Meriaudeau, F.; Downey, T.; Wig, A.; Passian, A.; Buncick, M.; Ferrell, T. L. Sens. Actuators, B 1999, 54, 106.
3. Morkoc H. Nitride Semiconductors and Devices. Springer: Berlin, 1999.
4. Jain SC, Willander M, Narayan J, Overstraeten RV. J. Appl. Phys. 87: 965, 2000.
5. McKeever, J., Boca, A., Boozer, A. D., Buck, J. R. & Kimble, H. J. Experimental realization of a one-atom laser in the regime of strong coupling. *Nature* 425, 268−271 (2003).