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# Dependence of ZnO-based Phosphor Spectral Emission on UV and X-ray Excitation Pulse Width

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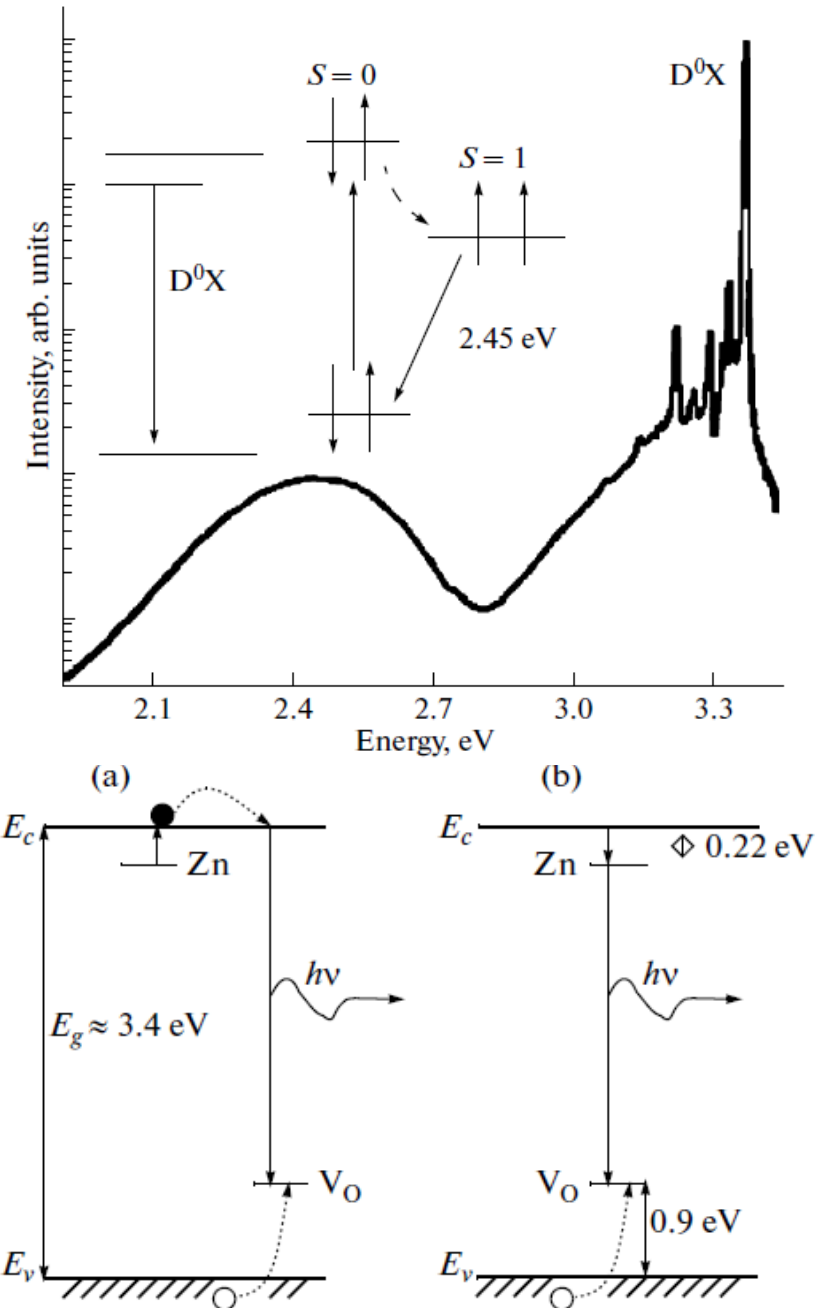
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# Introduction

- ZnO phosphors can exhibit UV and visible (green/yellow) emission bands
  - UV: exciton emission
  - Visible: various proposed luminescent centers, including  $V_{Zn}$ ,  $V_O$ ,  $Zn_i$ ,  $Zn_O$ , and  $Cu^{2+}$  ions
- Present study: ZnO:Ga and ZnO:Zn
  - ZnO:Ga: UV emission line resulting from exciton (edge) recombination
  - ZnO:Zn: UV band and broad green emission resulting from  $V_O$  point defects
- Application: **Phosphor Thermometry**
  - Both phosphors exhibit temperature sensitivity in their time-resolved and time-integrated spectral response

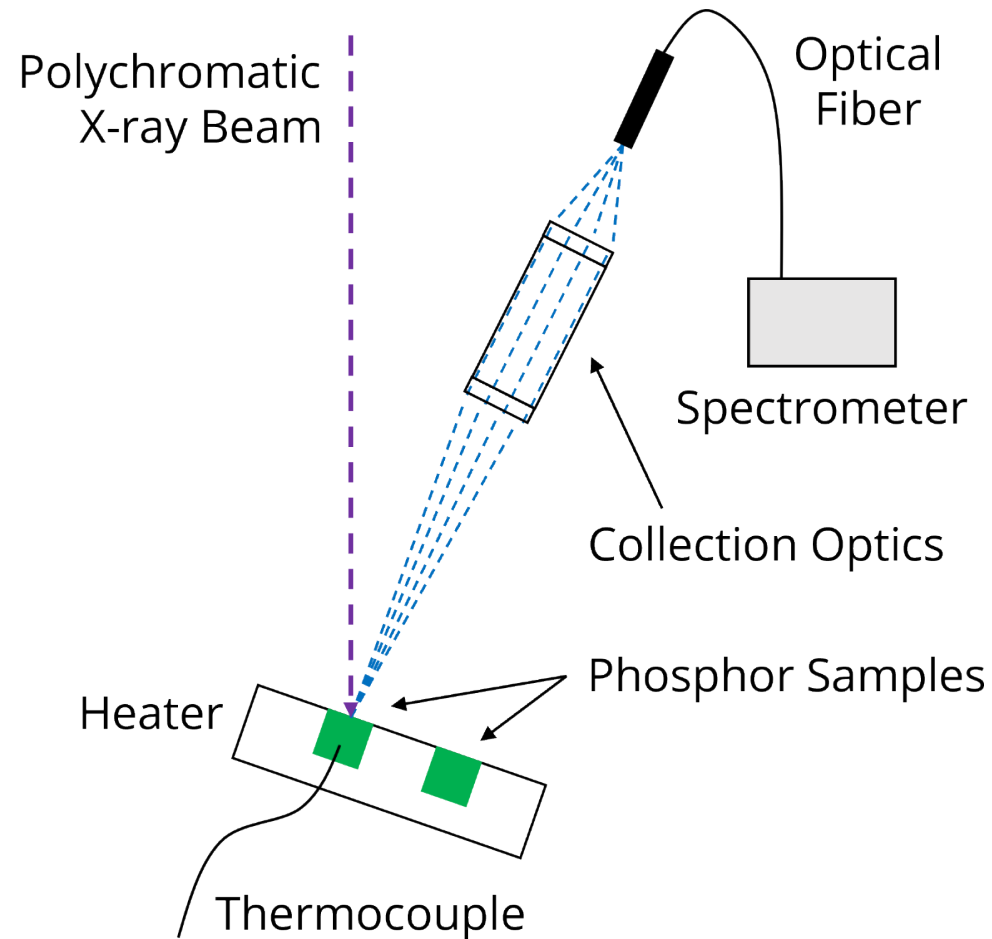
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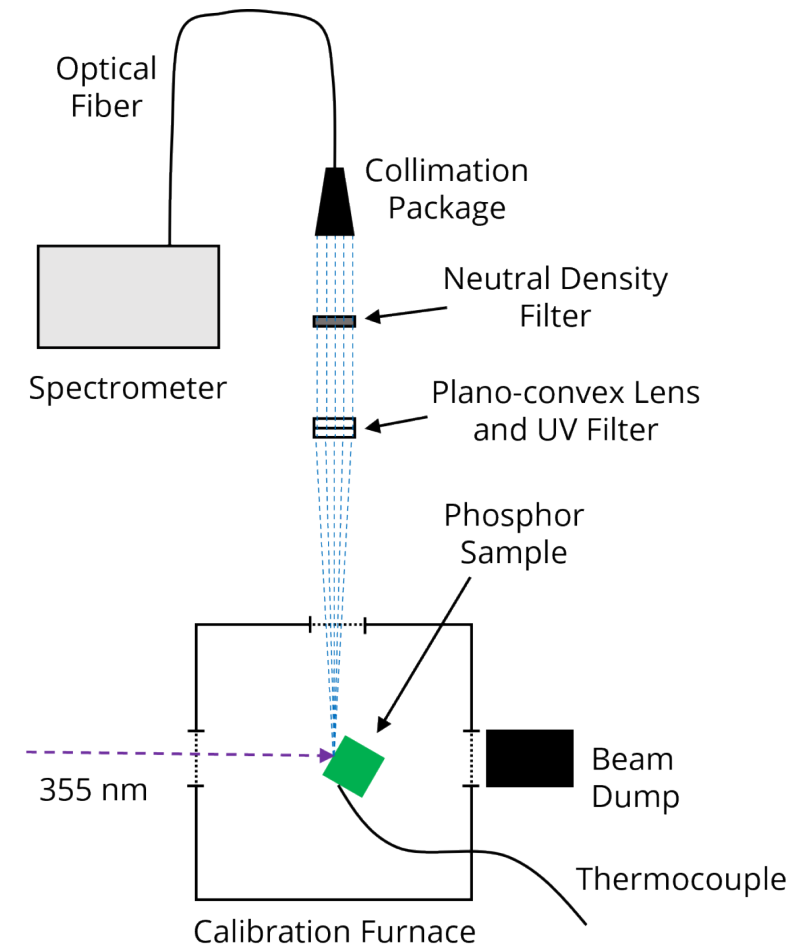


# Experimental Methods

## Synchrotron x-ray excitation

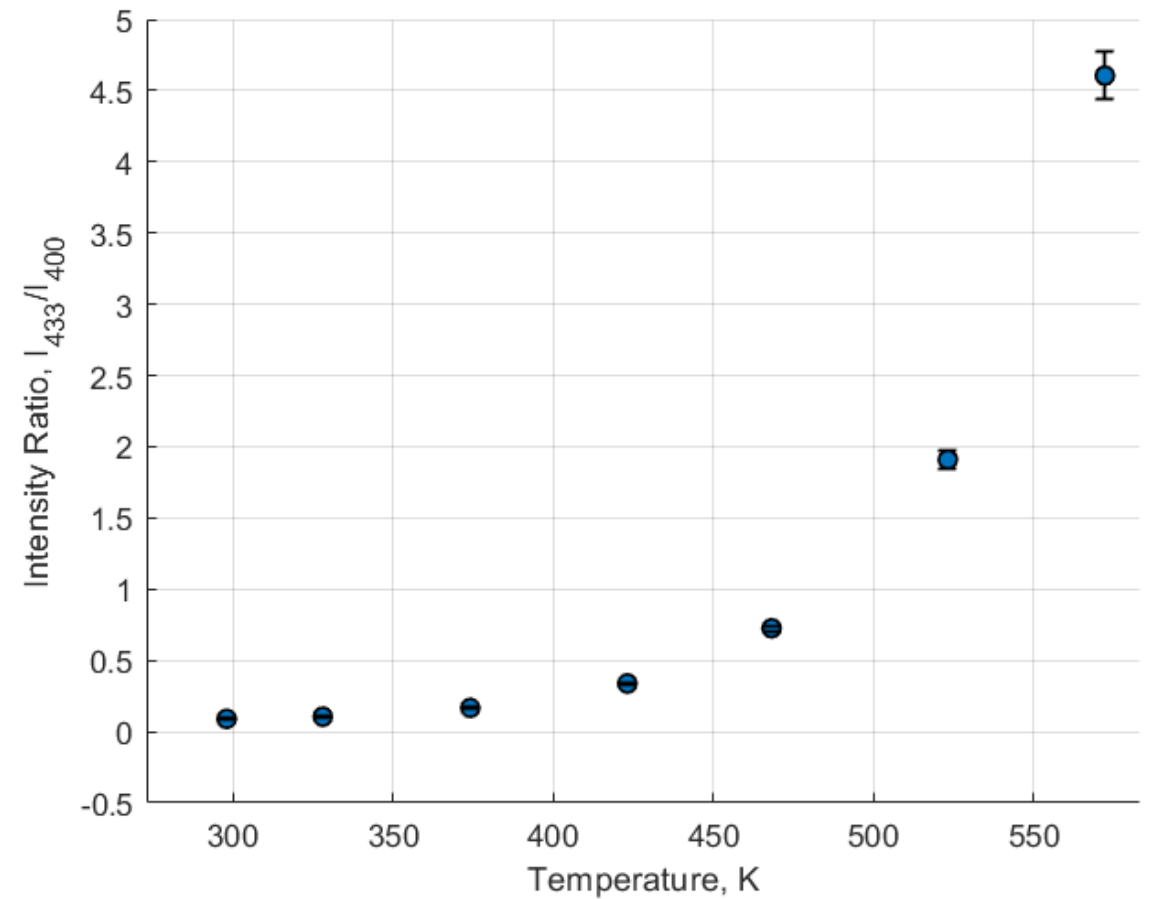
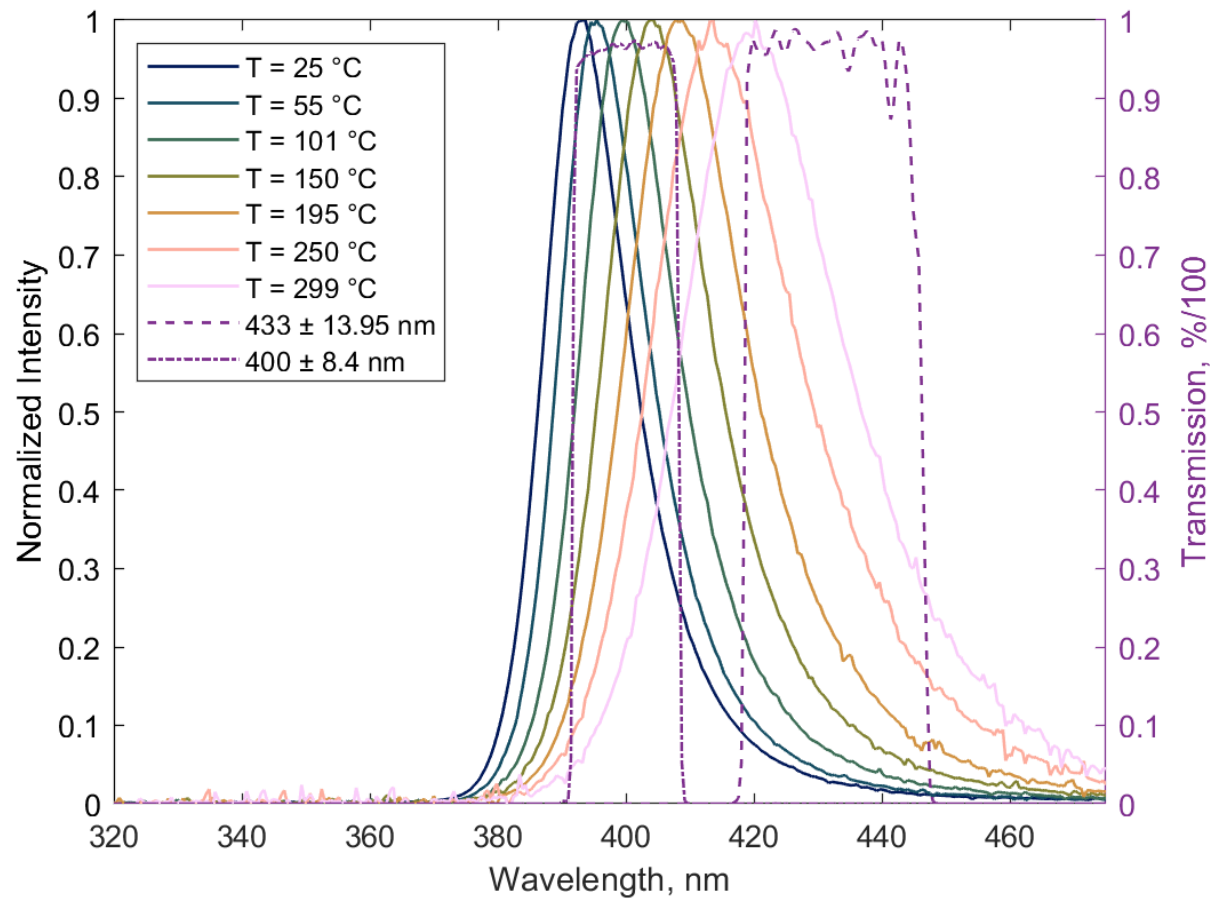


## Pulsed UV laser excitation



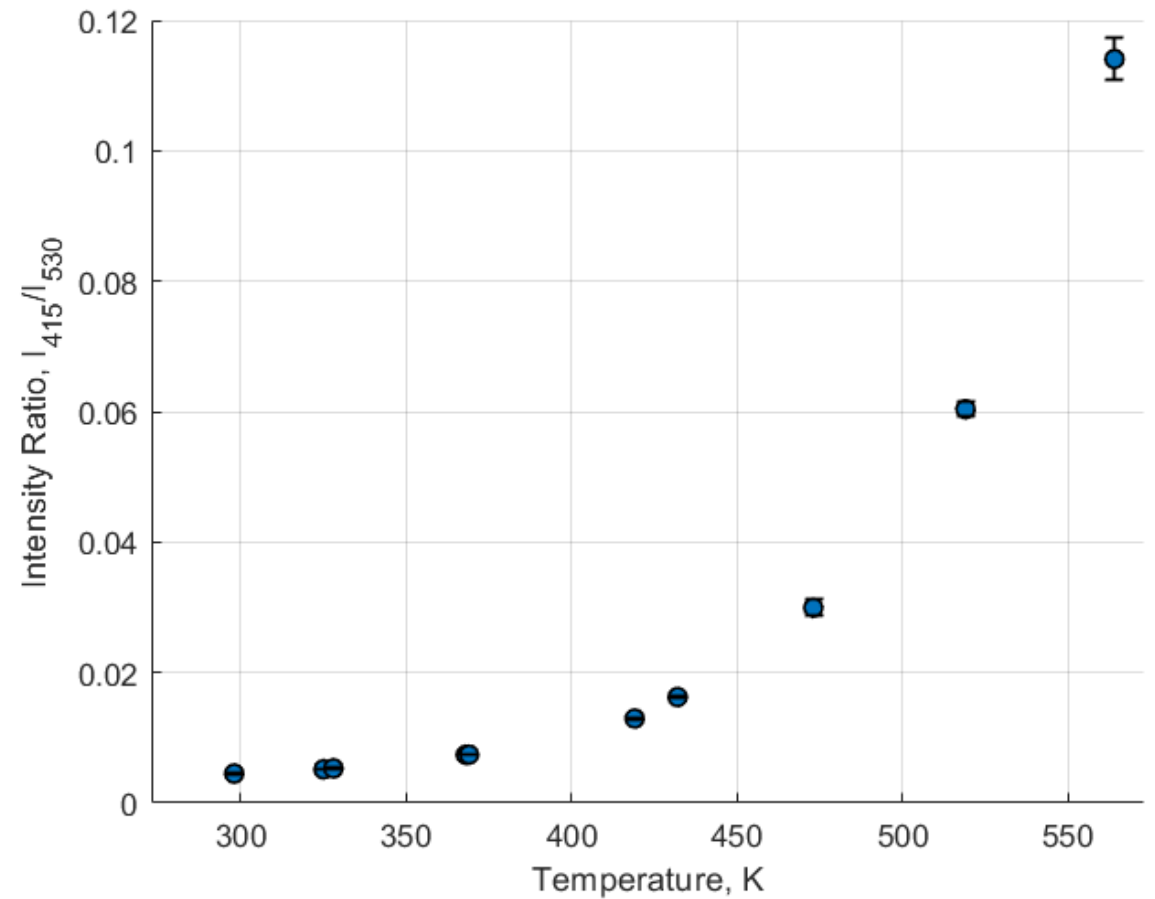
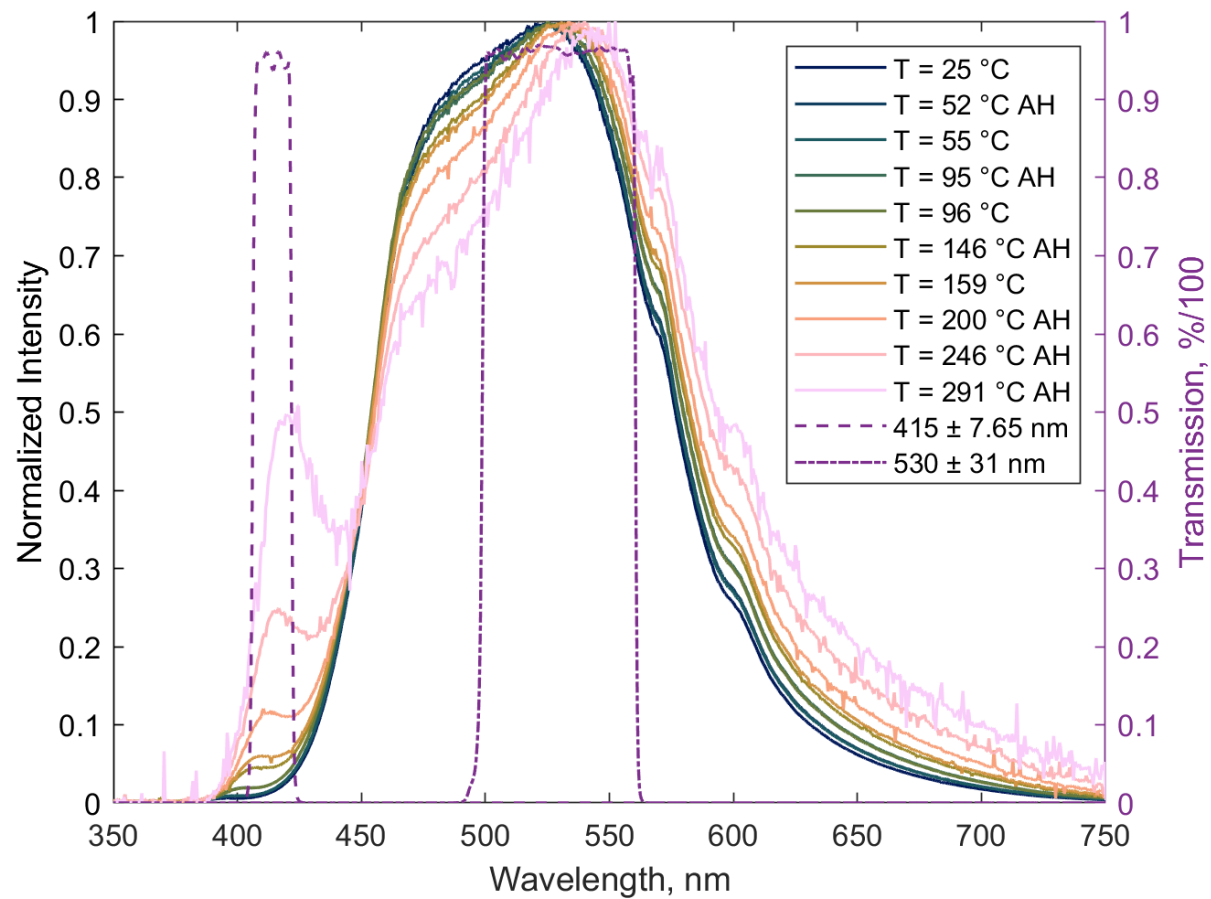
# Results – ZnO:Ga

UV emission line redshifts with increasing temperature



## Results – ZnO:Zn

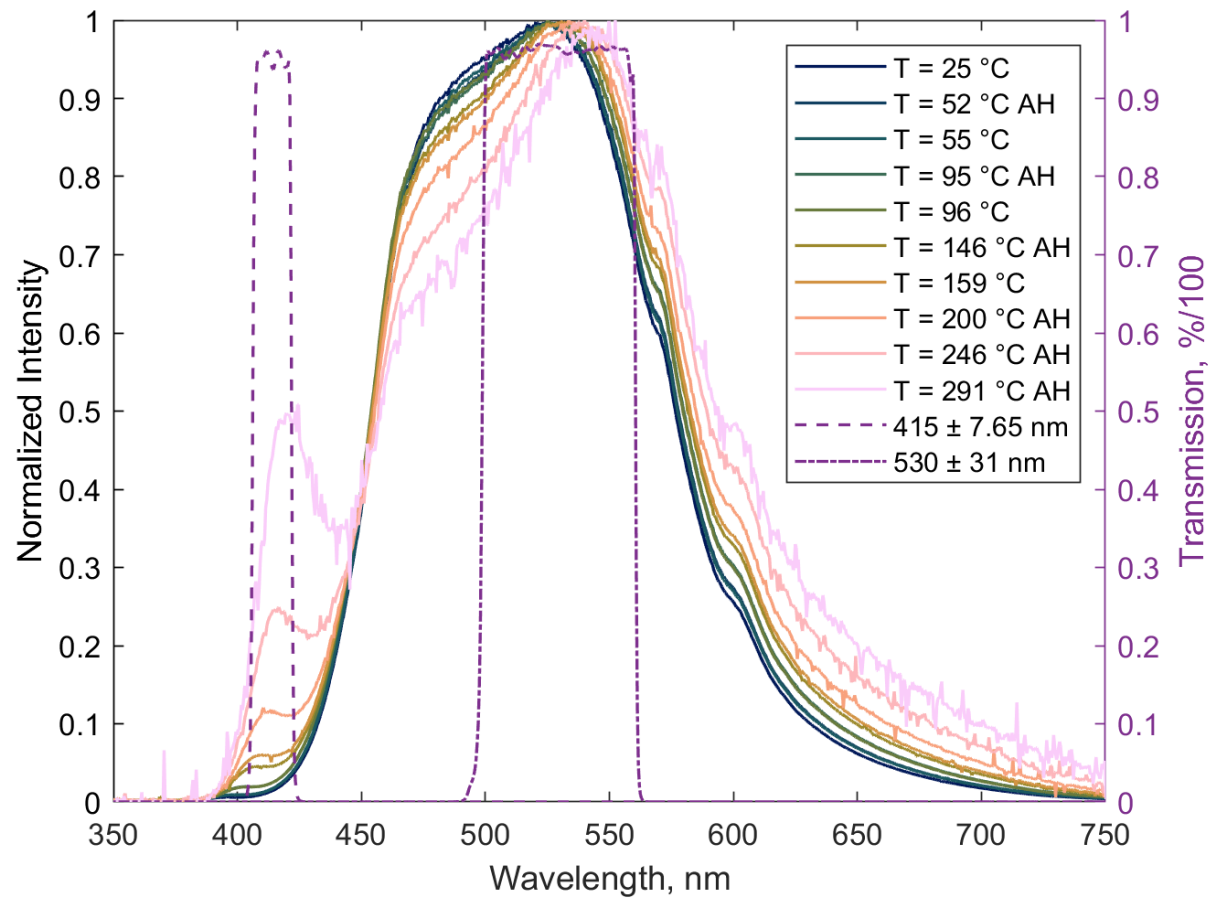
Same redshift of UV emission line, in addition to wide green emission band



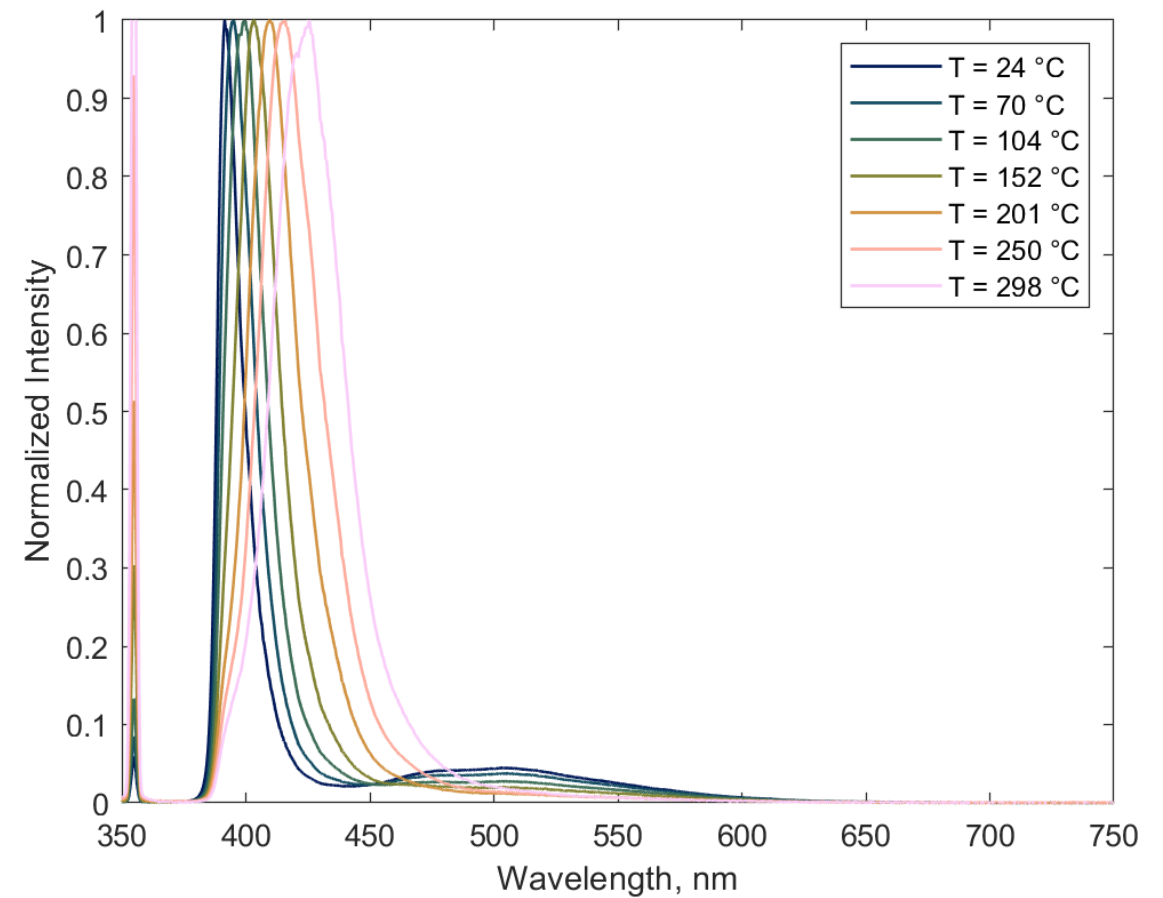
# Results – ZnO:Zn

Large difference observed in the relative intensities of ZnO:Zn emission

Synchrotron x-ray excitation



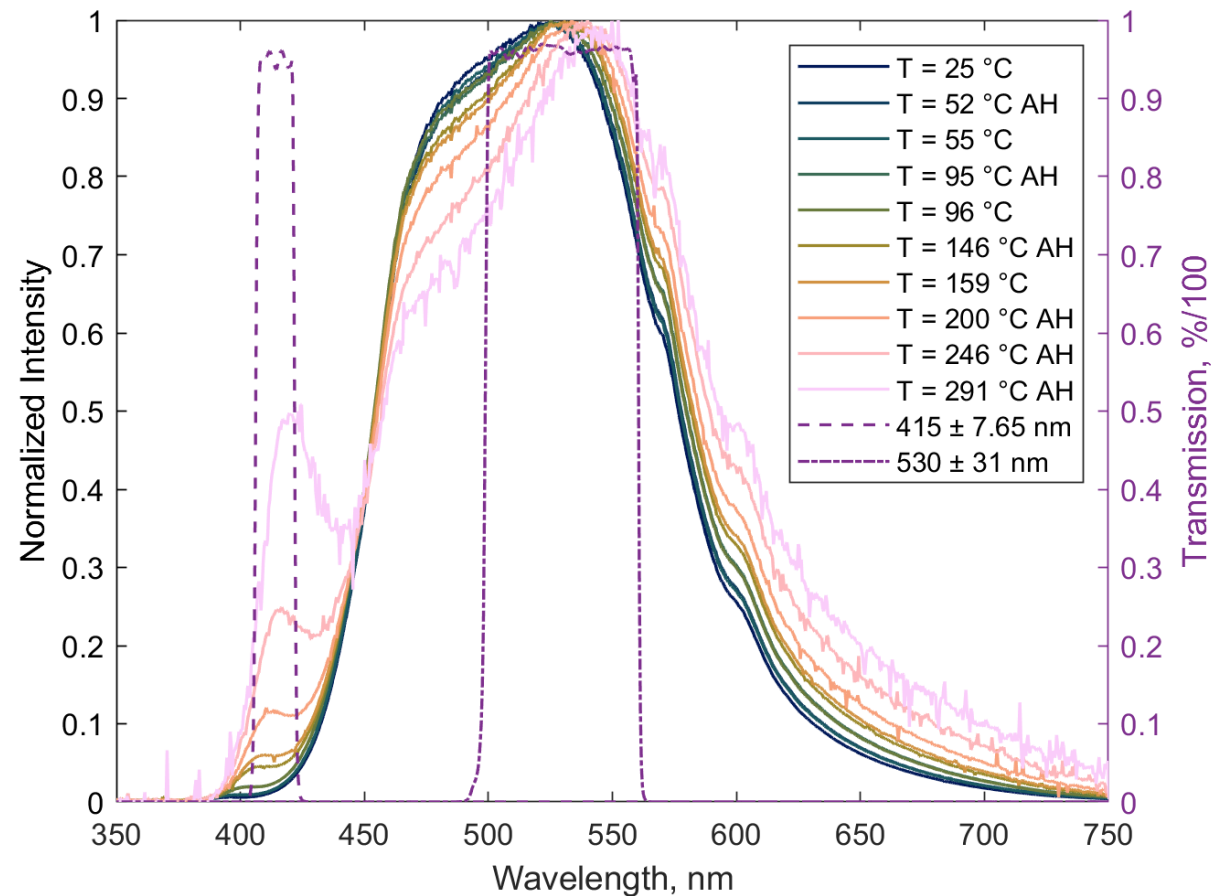
Pulsed UV laser excitation (355 nm)



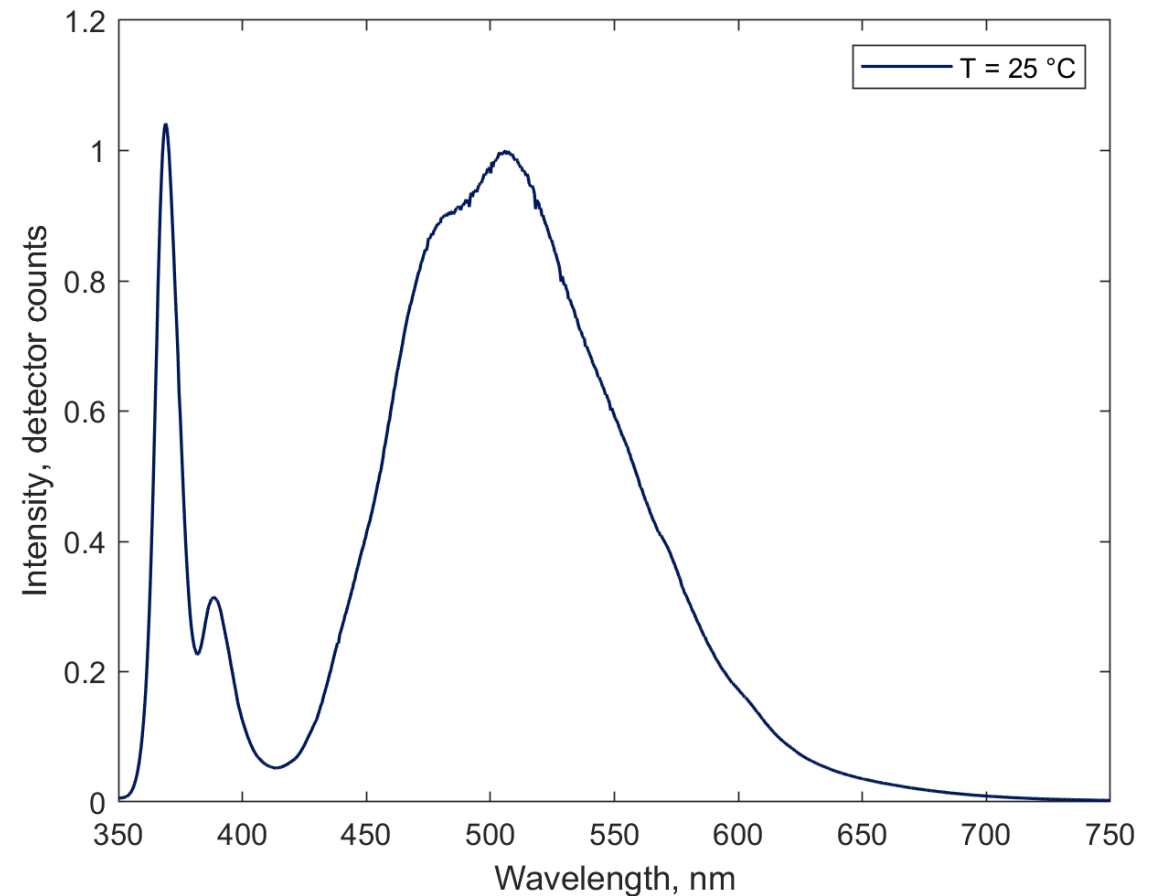
# Results – ZnO:Zn

Hypothesis: pulse duration, rather than photon energy, responsible for this behavior

Synchrotron x-ray excitation



Continuous UV LED (365 nm)

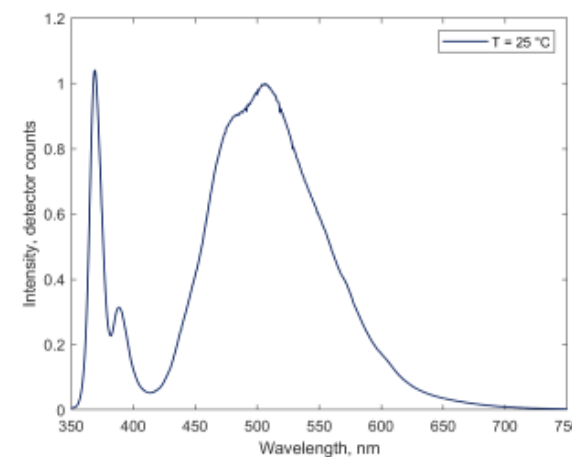
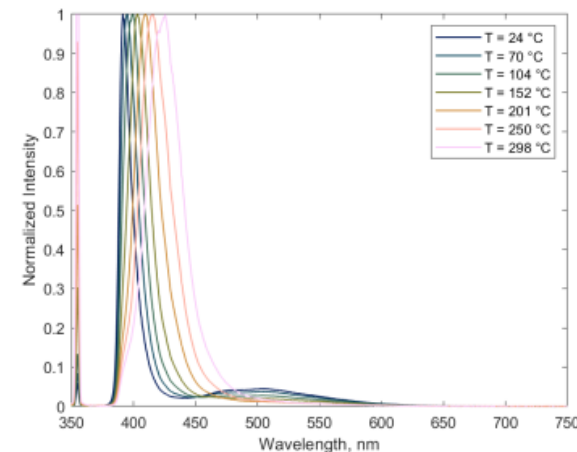
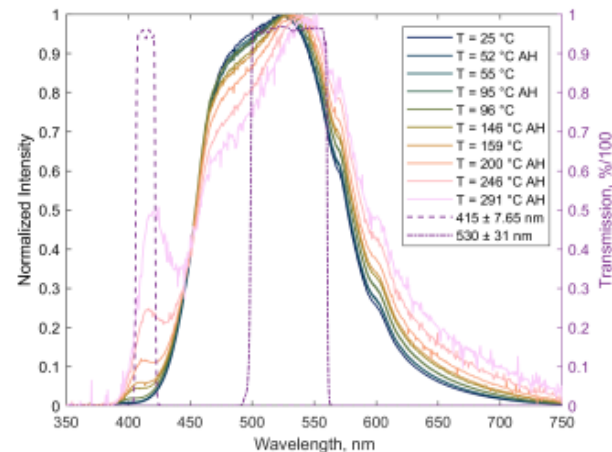






## Conclusions

- UV exciton luminescence observed from ZnO:Ga and ZnO:Zn
- Green emission band seen from ZnO:Zn
  - $V_O$  deep trap recombination process
- UV line redshifts with increasing temperature
  - Suggests a decrease in the band gap
- Relative intensities of UV and green emission bands differ dramatically between synchrotron x-ray and pulsed UV excitation
- Preliminary results suggests this is caused by the difference in pulse duration between sources
- Future Work:
  - Determine if there is a pulse width regime which shifts emission from UV dominant to visible dominant







## Acknowledgements

NASA Space Technology Research Fellowship grant No. 80NSSC17K0190 (E. R. Westphal)

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