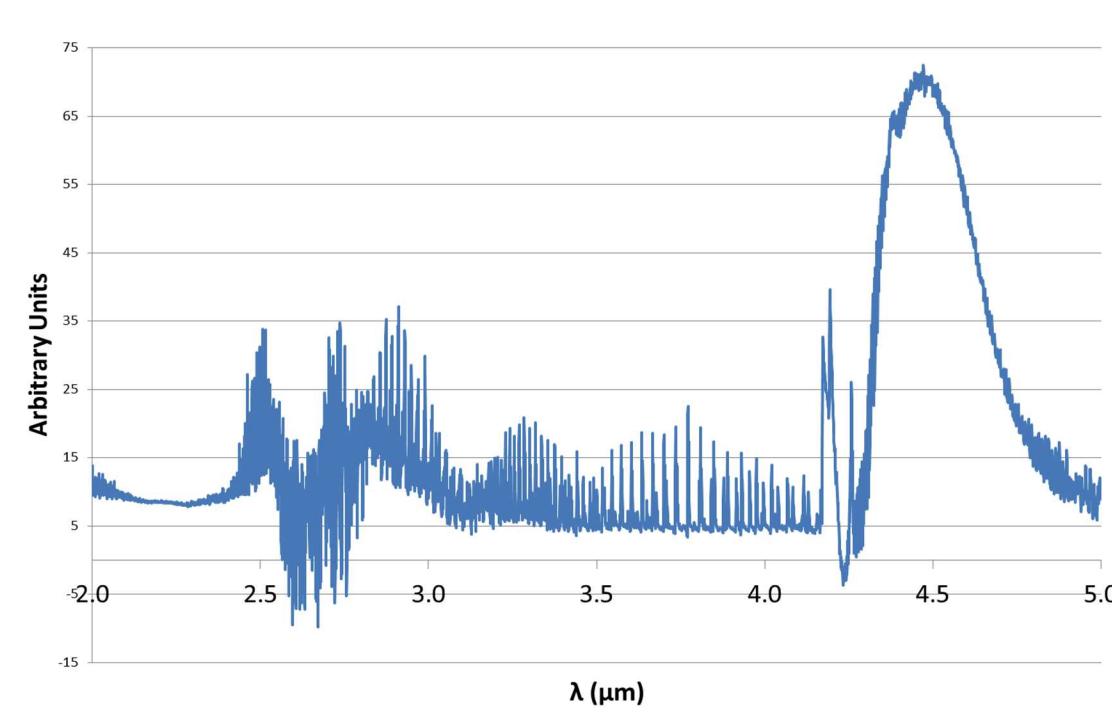
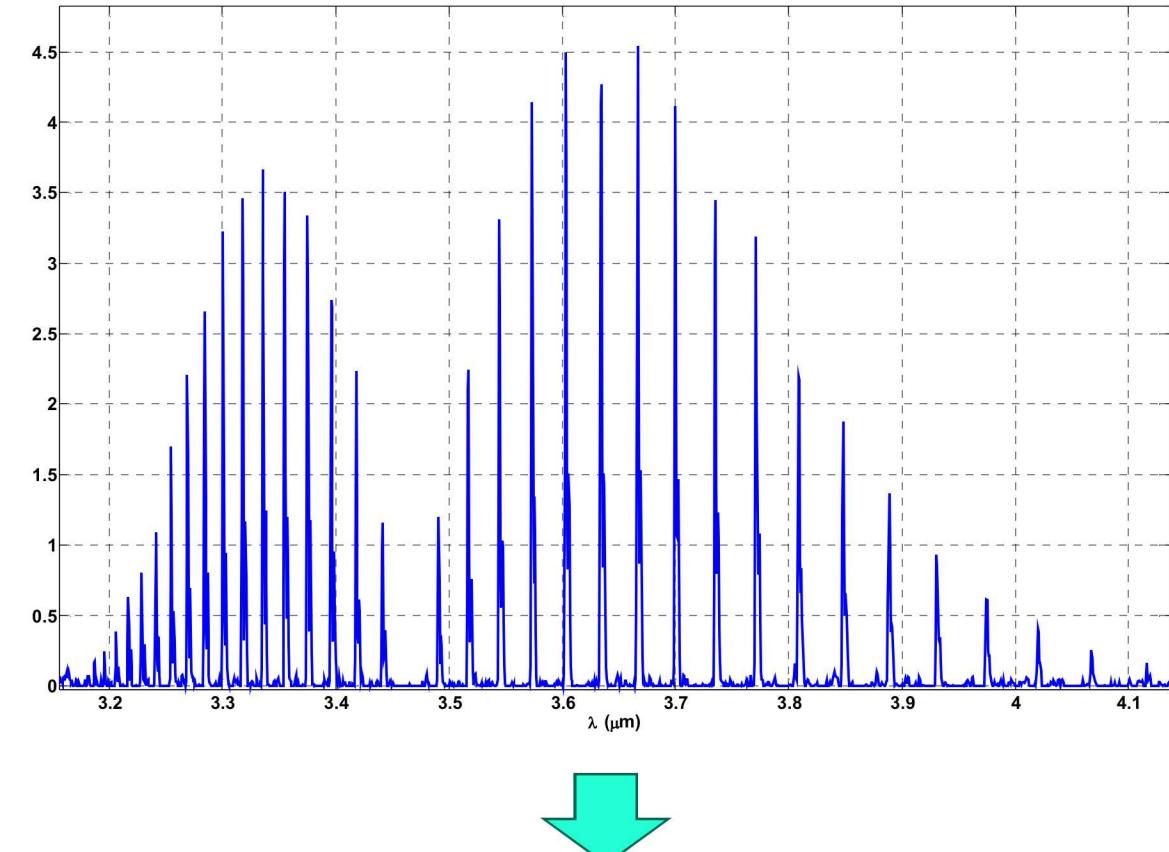
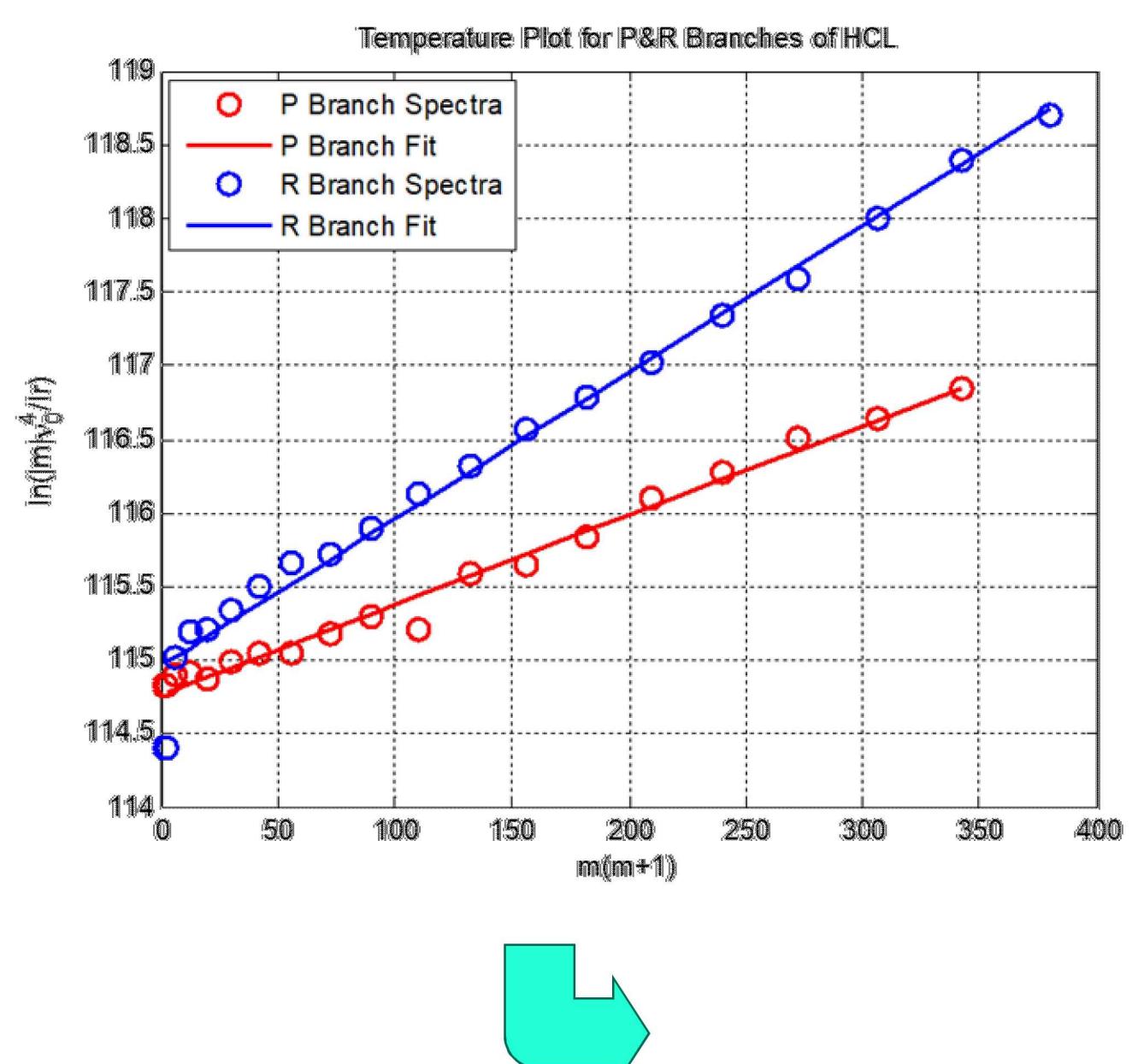




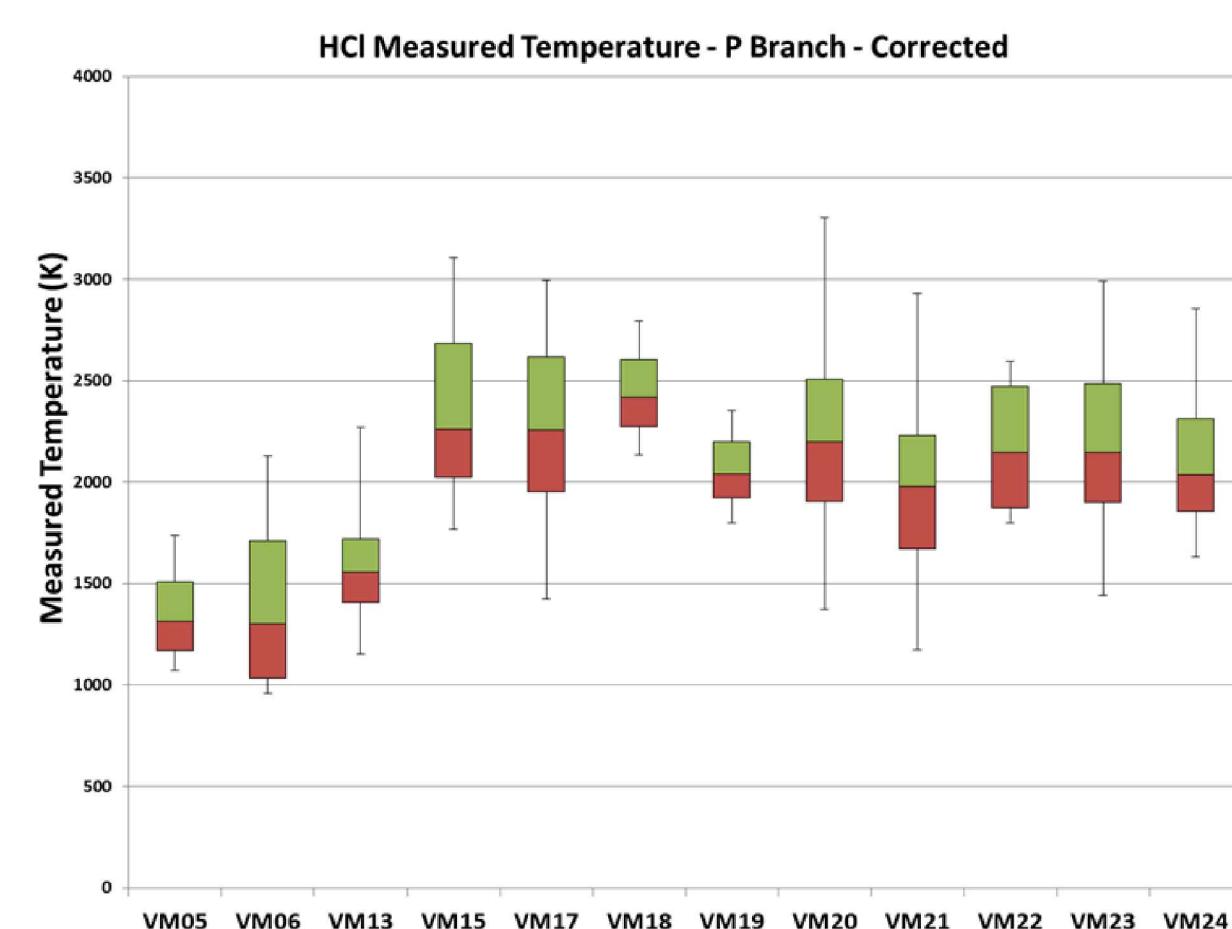
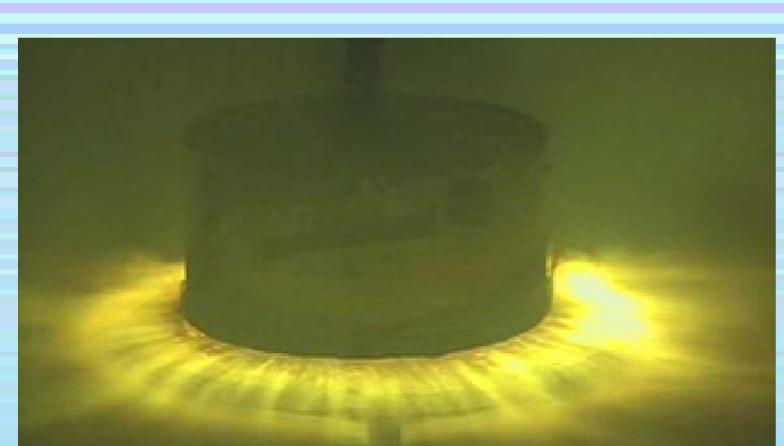
# Spectral Measurements of HCl and AlO from the burning of Aluminized Ammonium Perchlorate Solid Propellant

Alvaro A. Cruz-Cabrera<sup>1</sup>, Walter Gill<sup>1</sup> and David Surmick<sup>2</sup><sup>1</sup> Sandia National Laboratories<sup>2</sup> University of Massachusetts Lowell**Abstract**

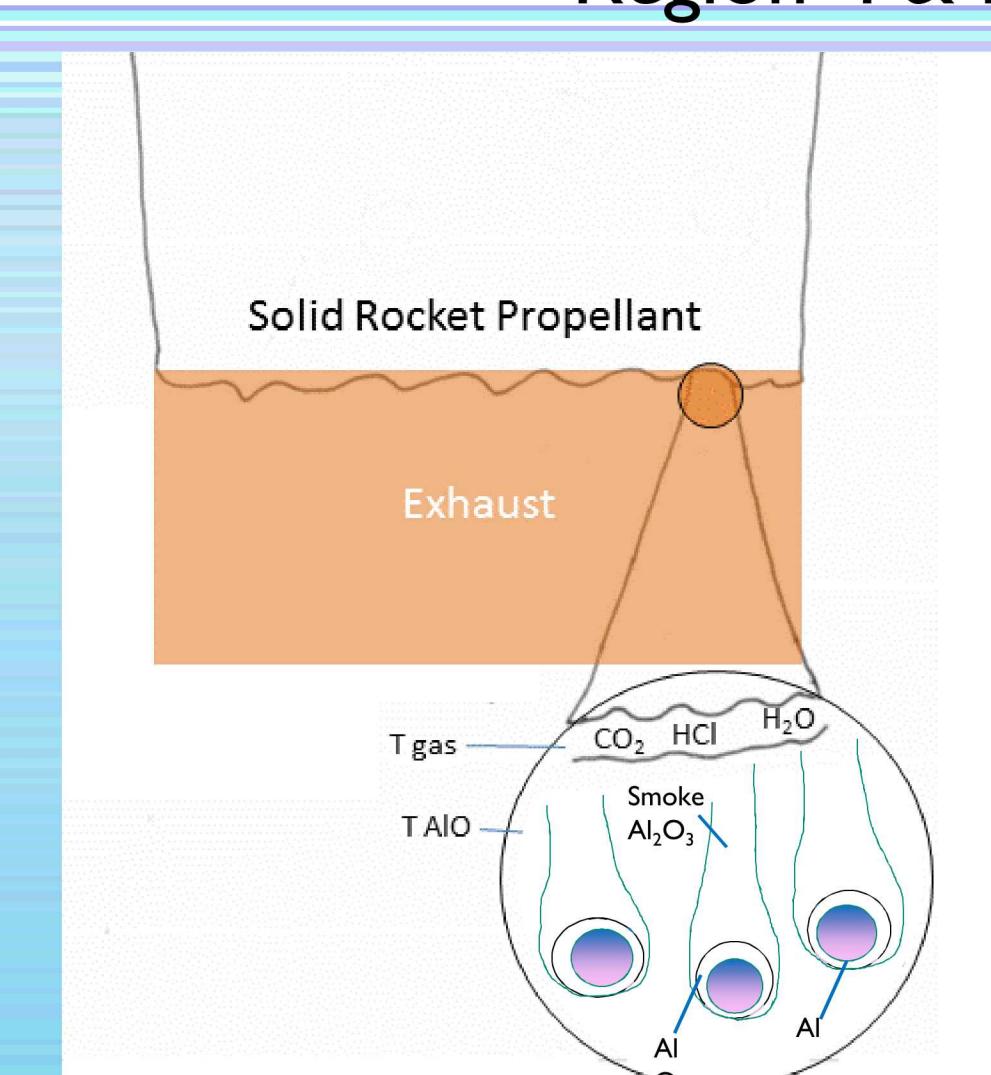
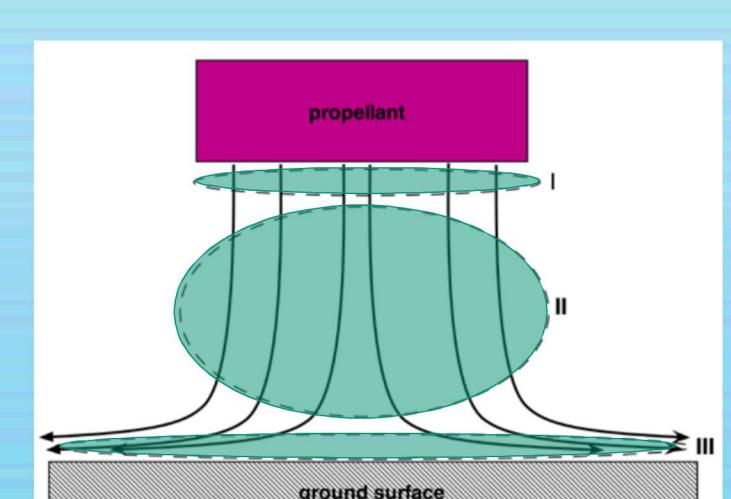
Spectral measurement of HCl gas and AlO particles emissions were performed in the plume burning of aluminized solid rocket propellant samples at atmospheric pressure. The aluminized ammonium perchlorate propellant plume contained burning liquid aluminum droplets due to the off design burning behavior at low pressure. This produced a non-thermal equilibrium plume containing high temperature burning droplets suspend in a lower temperature combusting gas envelope. The obtained spectra were used to estimate the temperature of the combustion gases and the temperature from the burning aluminum droplets. These experiments with burning propellant were intended to understand the hazards of an anomalous burn of the propellant during an accident or launch abort scenario.

**HCl Temperature Measurements****Collected Uncorrected Spectrum****Corrected HCl Spectrum****Fit For Linearized P & R Branches**

Aluminized ammonium perchlorate solid propellants, up to 16 inches (40 cm) in diameter, were tested at this facility

**Reported Temperatures from HCl Measurements****Background****Regions of Analysis**

- Aluminum combustion processes of particle agglomeration, ignition, and combustion in solid rocket propellant burning in **off design conditions** can be very different from the same processes in a **properly functioning** motor at high pressure and well defined geometry.
- We are concerned with **"Interaction"** as the process of hazardous material vaporization, condensation on available particulate and ultimate transport to the environment.

**Region I & II Dynamics**

- Region I shows the burning aluminum and ammonium perchlorate
- Multiple temperatures are present in Region II, complicating measurement and models
- AlO is believed to have some of the highest temperatures in this region
- Other oxides maybe present but we are not measuring them
- The smoke and soot (non aluminum related) has the lowest temperature in Region II, probably conforming to a grey body profile
- The gases (CO₂, H₂O, and HCl) fall in the middle of temperature ranges

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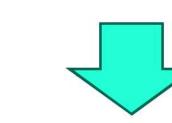
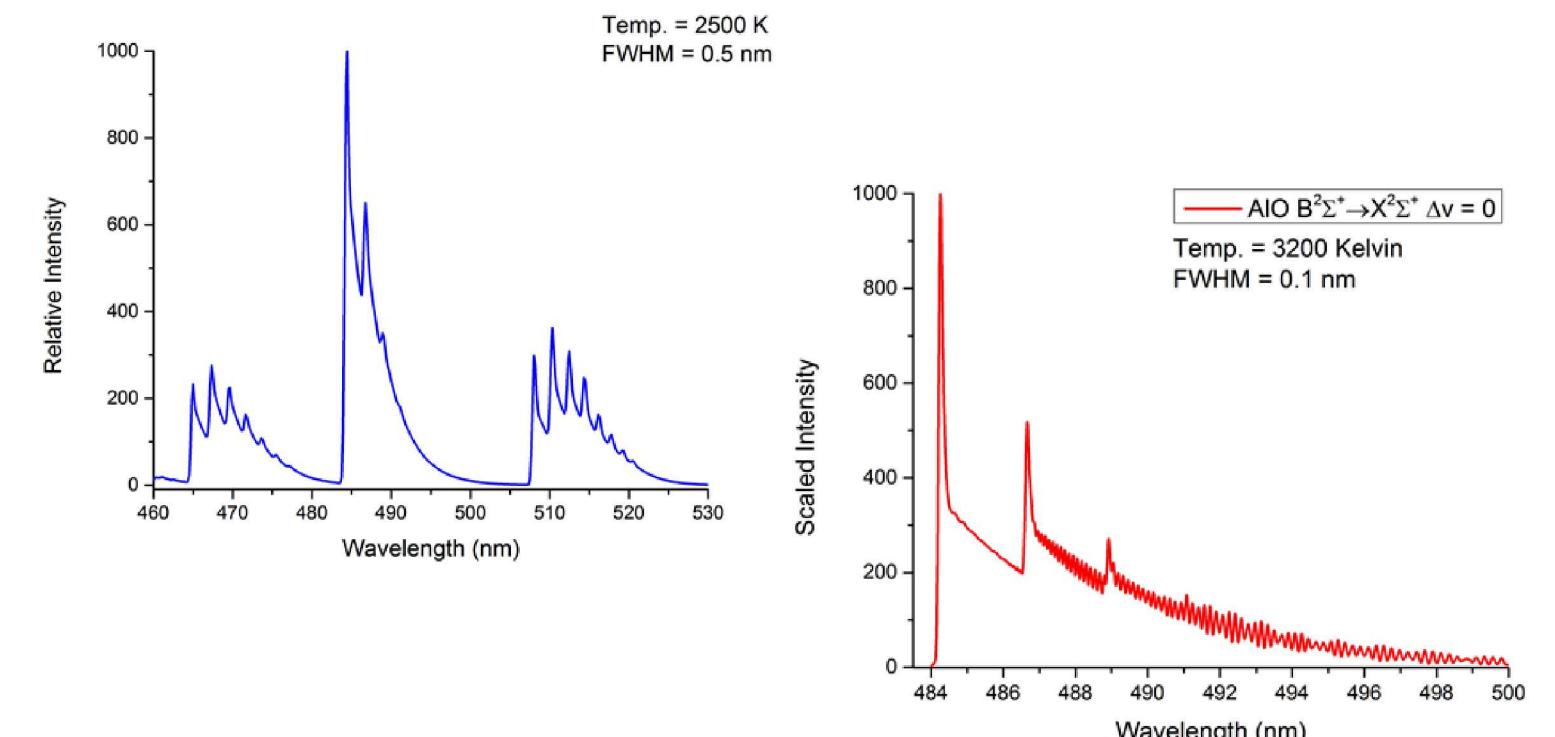
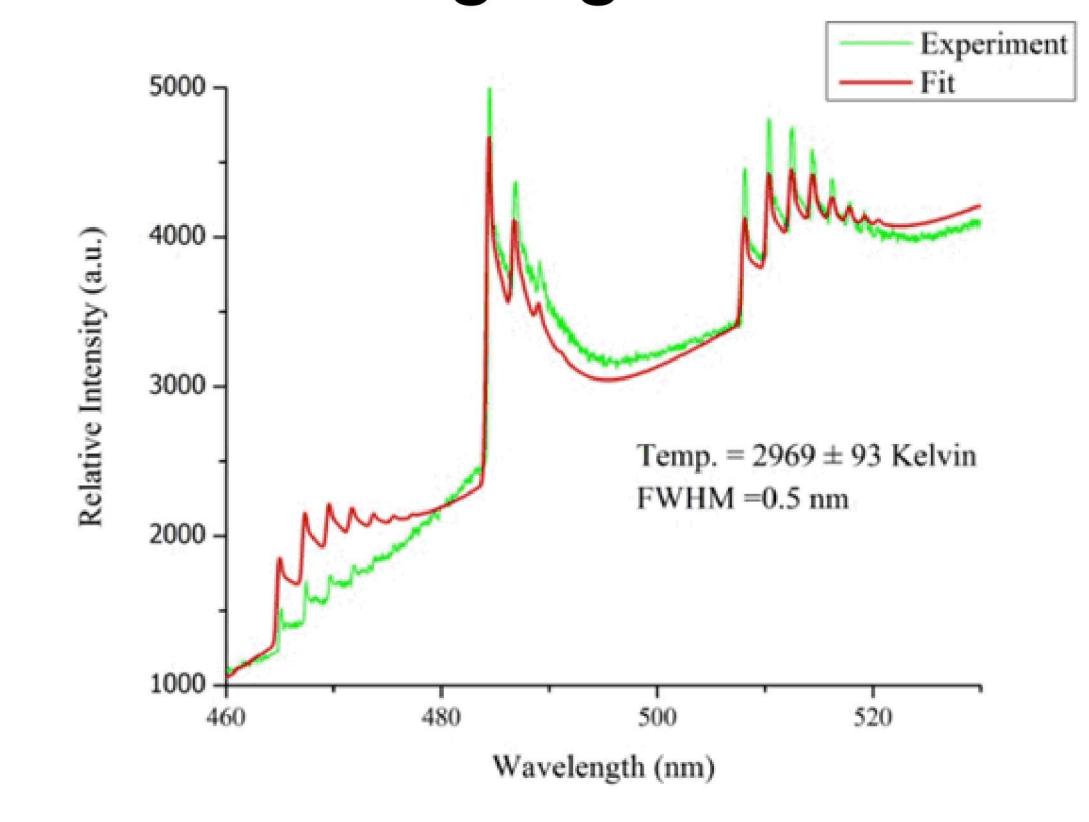
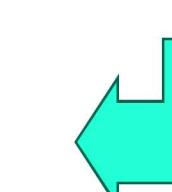
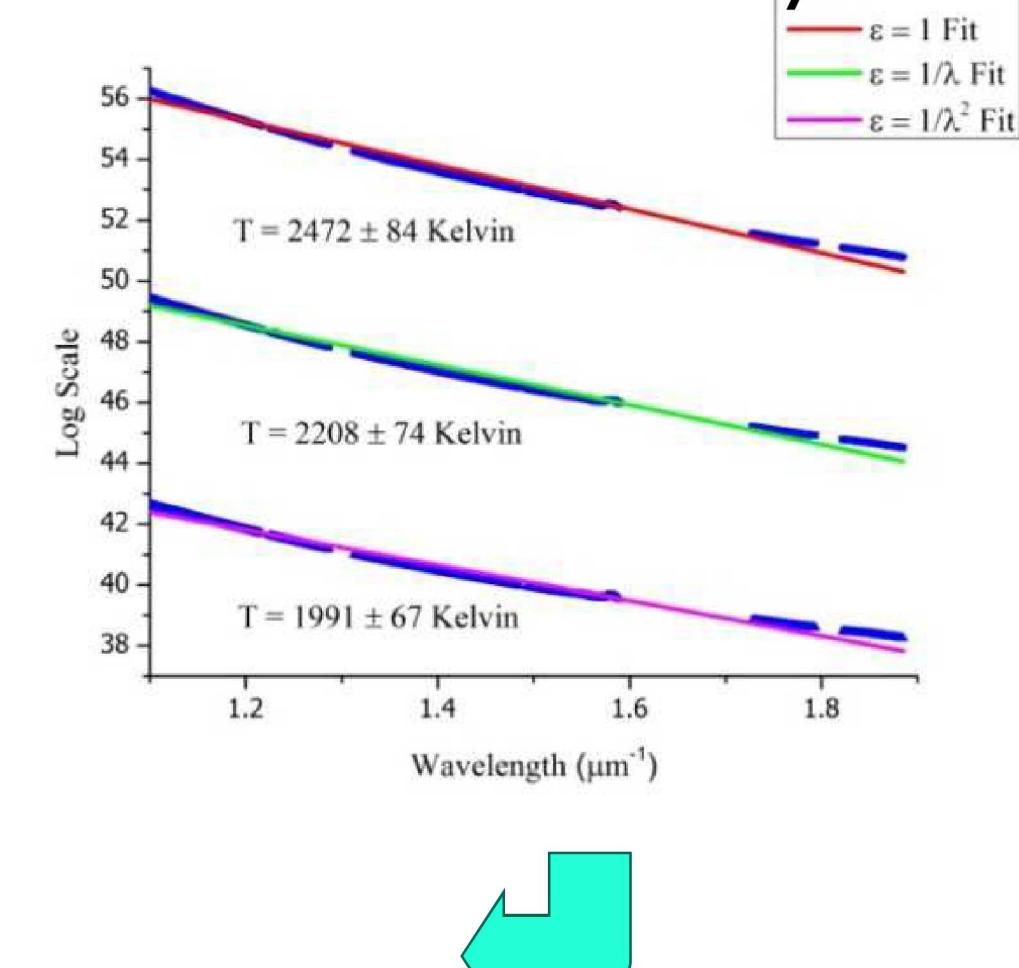
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**AlO Temperature Measurements****Theoretical Calculation of the AlO B2Σ+ → X2Σ+ Transition****Nelder-Mead Nonlinear Fitting Algorithm****Planck Fitting Results For Three Emissivity Models****References**

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