# Rapid Thermal Annealing of Vanadium Oxide Films for Tunable Photonics

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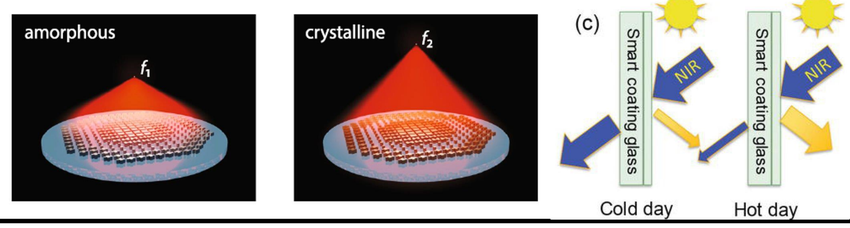
SMART SUMMER MATERIALS RESEARCH @ TULANE

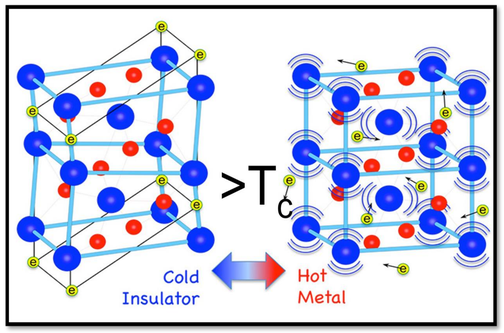
## Introduction

**Vanadium dioxide thin films are useful for the creation of tunable photonic devices, smart windows and other opto-thermal devices**



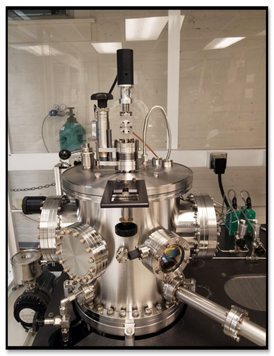

## $VO_2$ Background

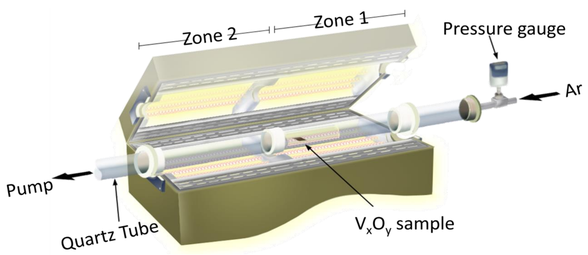
- **Vanadium dioxide is a phase transition material**
- **$VO_2$ has a reversible transition between phases around 68°C**
- **At lower temperatures, it acts as an insulator while at higher temperatures, it behaves as a metal**




## Film Deposition

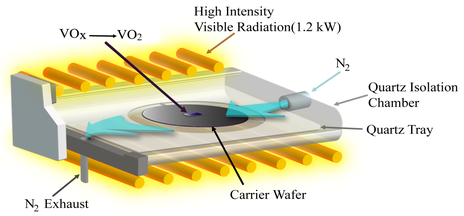
- **$VO_x$ films are deposited in a two-step process:**
  - **Sputtering – Deposits a mixture of oxides**
  - **Tube Annealing – Reduces $VO_x$ to $VO_2$**

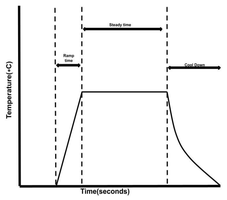





## Rapid Thermal Annealer

- **Faster and more precise than tube annealing**
- **Uses high intensity visible radiation to heat single wafers for short process periods of time at precisely controlled temperatures.**
- **Atmosphere is saturated with $N_2$ to reduce Oxygen content.**

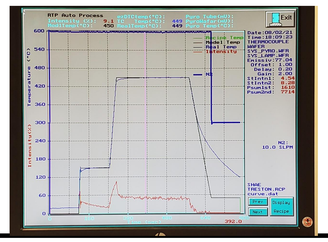



## Annealing Parameters

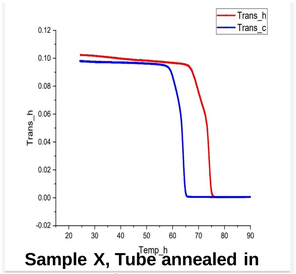
**RTA process optmization was done by varying the following parameters:**

| Parameter | Value |
|---|---|
| Process gas | $N_2$ |
| Steady Time | 60-1200s |
| Temperature | 450-500, primary; 300-600, total |
| Flow rate | 10 slpm |

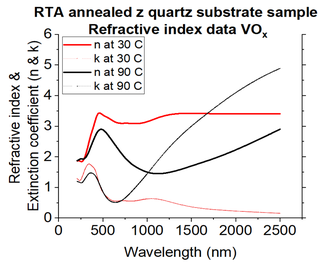


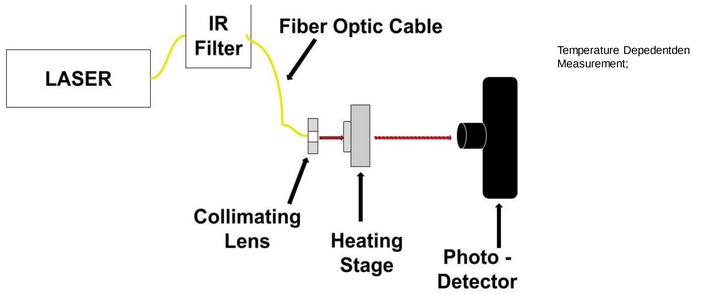

## Measurement Goals

**To observe whether the annealed films have successfully been reduced to $VO_2$, temperature dependent Transmittance measurements were done**



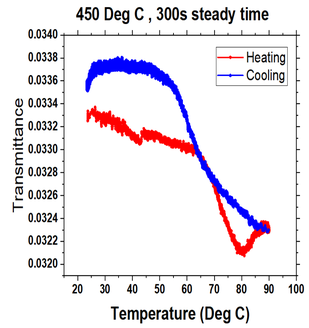

**Sample X, Tube annealed in Ar Atmosphere**

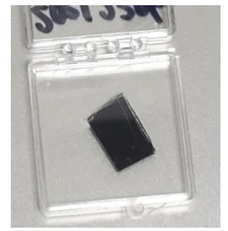


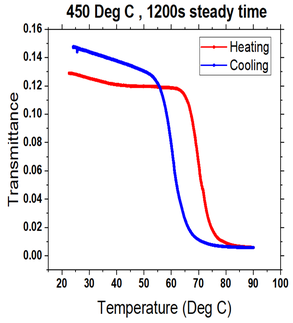



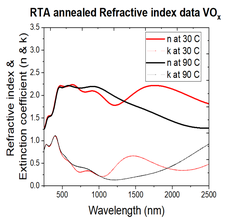

Temperature Depedentden Measurement;

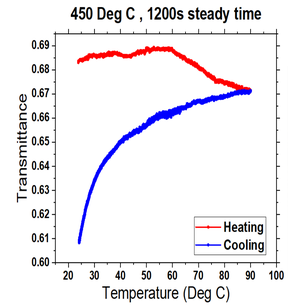
## Results

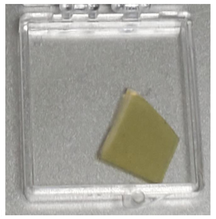




## Conclusion

**With the assistance of external elements like forming gas, RTA has the potential to produce $VO_2$ films from sputtered $VO_x$ films**

## Acknowledgements

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