

Effects of High Temperature Annealing on VO₂ Phase Transition Temperature

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Research Question

This project seeks to address how annealing vanadium dioxide at high temperatures affects the phase transition temperature and the change in transmittance between the metallic and insulating phases.

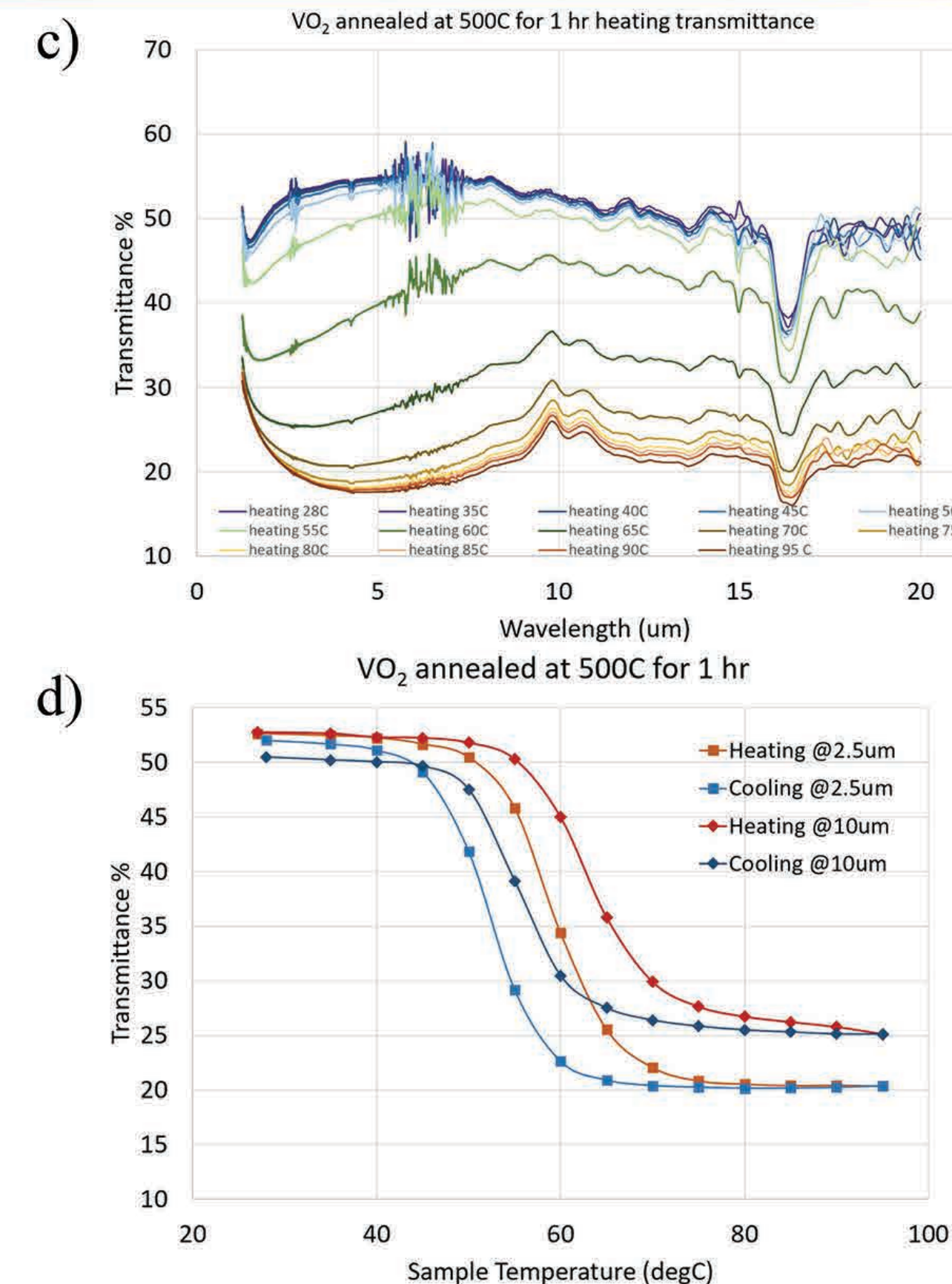
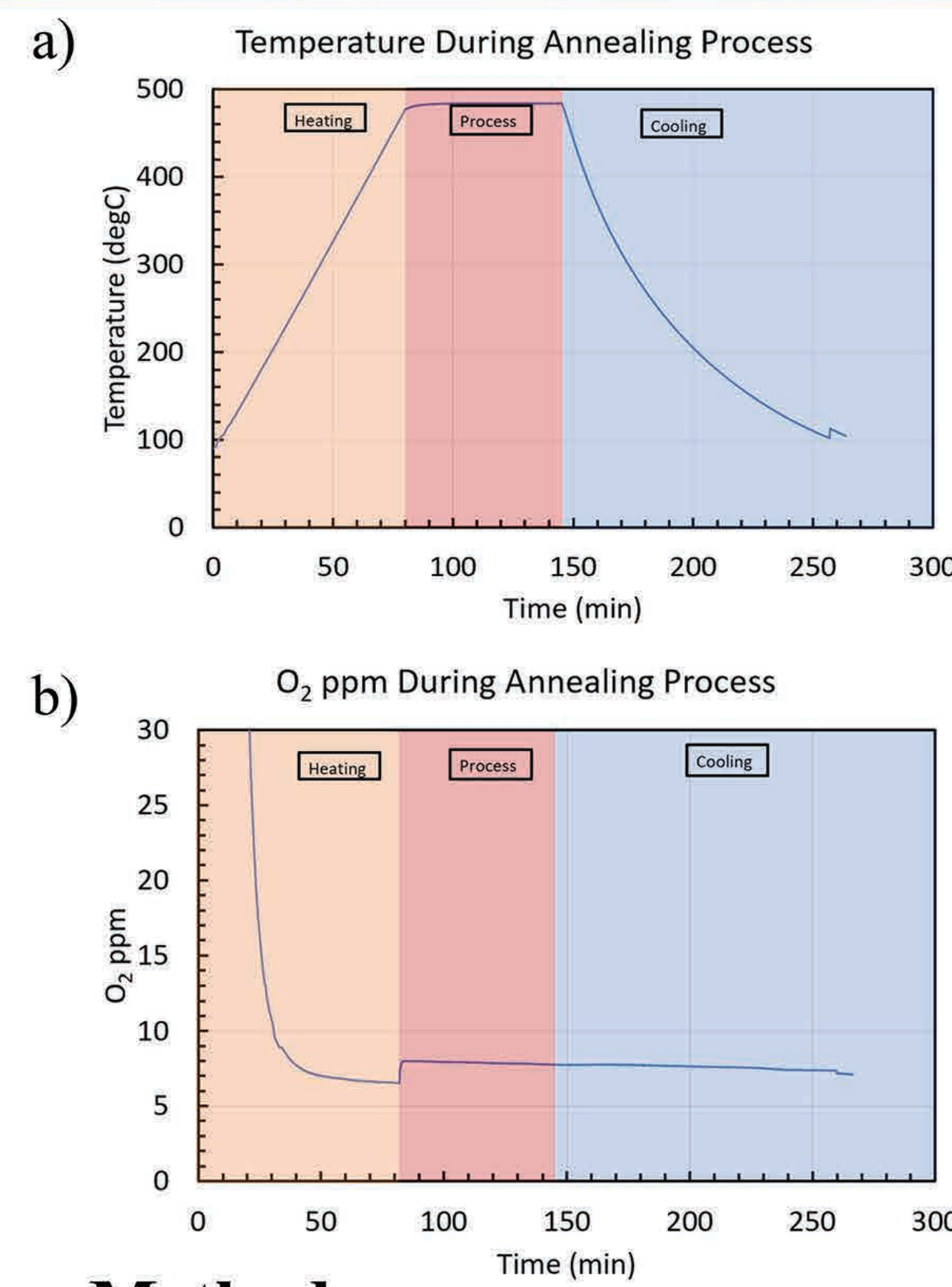
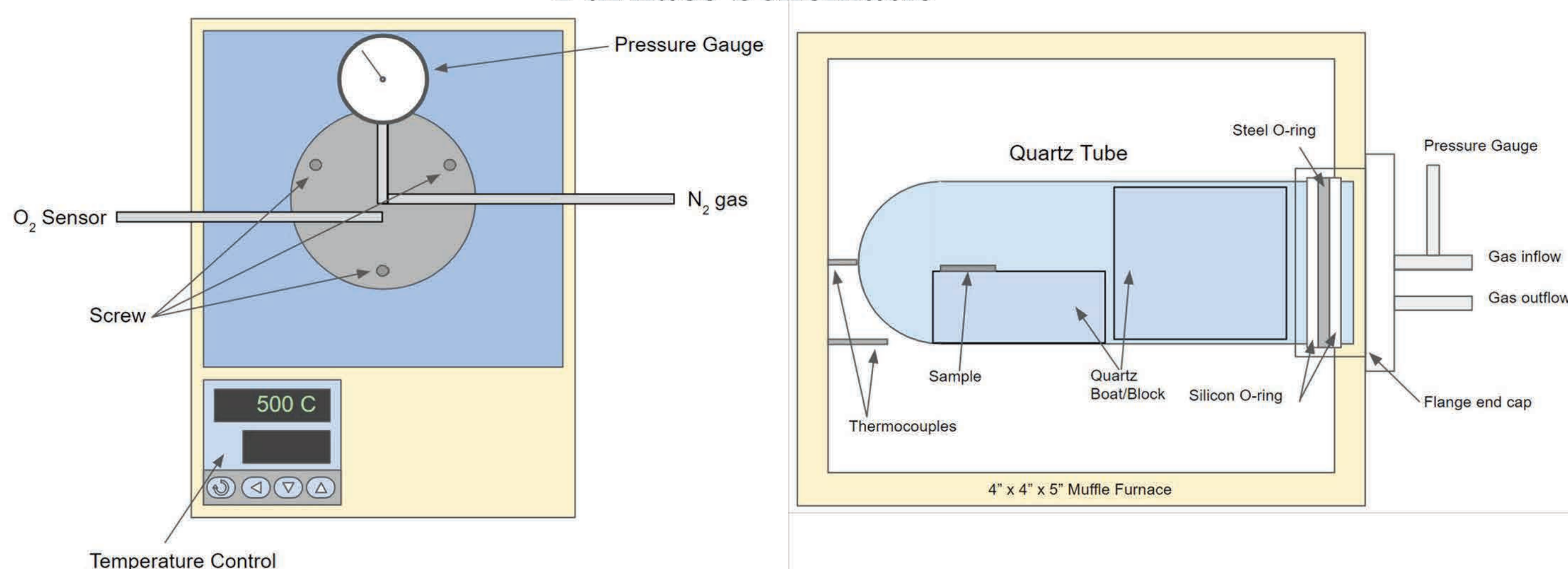
Motivation

The insulator to metal phase transition of VO₂ happens around 68°C, and if the phase transition temperature could be lowered to ambient temperature, this material would be even more useful as a thermal control for spacecraft or smart window applications.

Results

The phase transition temperature for the sample annealed at 500°C for 1 hour happens from 57-68°C, as seen in figure d. The hysteresis of the sample annealed at 500°C was smaller than those seen in literature, and it is expected that at higher annealing temperatures the hysteresis would be even smaller.

Furnace Schematic



a) The temperature of the furnace during the annealing process of the sample.

b) The amount of O₂ in the furnace during the annealing process of the sample.

c) Depicts the transmittance spectra of the sample from FTIR as it is being heated. note that as the sample is heated the transmittance decreases, showing the switch from the insulating to metallic phases.

d) Shows the heating cooling curve of the sample at different wavelengths to find the transition temperature and see the hysteresis.

Methods

Samples of 25 nm vanadium on silicon substrates were placed in a furnace. the sample is heated at a rate of 5°C per minute with 2 lpm of N₂ gas being pumped into the furnace. Once the annealing temperature is reached, the gas flow rate is decreased to 1.5 lpm and the temperature will be held constant for 1 hour before being cooled. during this annealing process the vanadium is oxidized and becomes VO₂. FTIR is used to measure the transmittance of the sample as it is being heated and cooled 5C at a time. As seen in figure d, the change in transmittance measured reveals the phase transition temperature.

Future Work

High temperature annealing could be tested on tungsten-doped samples of VO₂ to further understand the effects of annealing on the phase transition temperature.