

5. Experimental Example

5.1 Installing Sample

- 1) Twist the long M4 screw into the screw hole at one end of a sample.
- 2) Pull out the sample from the sample rack by holding the M4 screw (avoid touching the sample with your hand).
- 3) Lay the sample down, measure and record sample original length l_0 with a caliper.
- 4) Remove the oven from the side platform of the main unit by releasing the two **thumb screws** (one on either side).
- 5) Remove the temperature sensor from the oven.
- 6) Hold the M4 screw on the sample and carefully insert the sample into the oven.
- 7) Align the side hole on the sample with the side hole of the oven for sensor placement.
- 8) Insert the temperature sensor head into the hole on sample through the oven side hole and push the sensor handle till touching the oven wall.
- 9) Unscrew the M4 screw from the sample and replace with the movable mirror by twisting the screw on the backside of the mirror into the sample screw hole.
- 10) Restore the oven on the side platform of main machine by fixing two thumb screws.
- 11) Connect power line of the oven to the main unit.

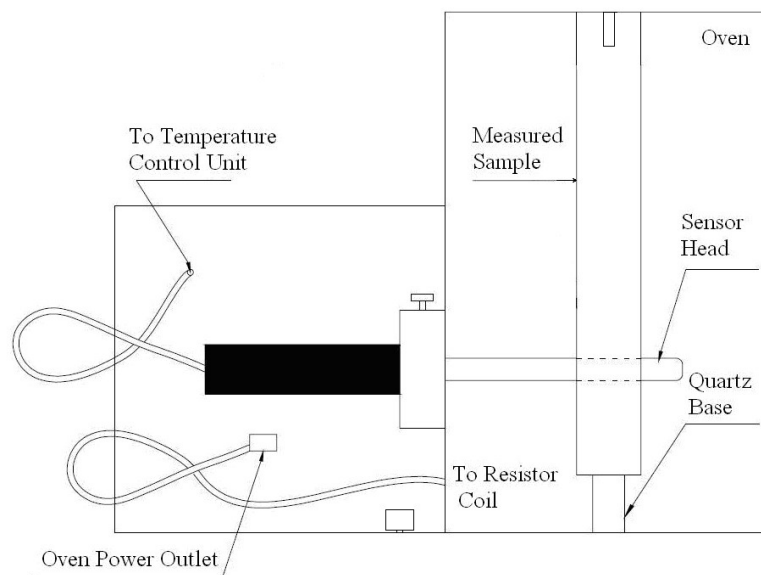


Figure 2 Schematic of oven

5.2 Installing Laser

- 1) Connect high voltage line of the He-Ne laser tube to main unit.
- 2) Connect power cord of the main unit and switch on power.
- 3) Push down “Laser” button to turn on the laser, adjust the laser such that it is parallel to the main unit and is incident on the lens of the beam expander.
- 4) Flip the Beam Expander 90° out of the optical path.
- 5) Adjust the screws on the back of mirrors M1 and M2 so that the two main light spots superimpose on the viewing screen.
- 6) Flip Beam Expander back into optical path and now an interference pattern can be observed on the viewing screen.
- 7) Fine adjustment of the mirrors M1 and M2 to bring the centre of interference pattern (rings) to a more appropriate location on the screen
- 8) Fine adjustment of the Beam Expander to achieve best brightness and uniformity of the pattern on screen.

5.3 Measuring Coefficient of Thermal Expansion

Two methods can be used in this experiment

- Preset temperature variation amount (e.g. 10 °C) to measure sample’s length change
- Preset length change (e.g. the optical path difference of 50 or 100 fringes variation) to determine the required temperature increase

5.3.1 Preset Temperature

- 1) Select “Setting” mode on Temperature Control Unit, and turn the adjustable “Setting Knob” until the desired temperature value is displayed
- 2) Then, remember the profile of central region of the interference pattern, select “Measure” mode by pushing down the button and record sample’s original temperature t_0 .
- 3) Carefully count the number of fringes created from the center during heating (using the provided hand tally counter). While count reaches preset number (e.g. 50), record current temperature t .

- 4) Finally, the sensor will automatically turn off the oven when the preset temperature value is reached and the red light turns on. You may also directly push “Pause” button to turn off oven after complete measurement of one sample.
- 5) If room temperature is lower than the linear range of the sample thermal expansion, you may pre-heat the sample to the expected temperature as its original temperature. Set temperature above 60 °C if manual temperature control is used.
- 6) The relationship curve between expansion amount and temperature changes can be acquired by recording fringe variation numbers at different temperature points.

5.3.2 Preset Length

- 1) Calculate the required temperature variation ($t-t_0$) under preset fringes change amount N (e.g. 50 or 100) according to Equations. (2-1) and (2-2).

NOTE: if automatic control of heating is used, the preset temperature value should be 3.0 °C higher than the calculated value, since the sensor will automatically turn off the oven power supply at 3.0 °C lower than its preset value. So the preset temperature value should be: **original temperature + required temperature variation + 3.0°C.**

- 2) Continue on as above from step 2

5.4 Changing Sample

- 1) Turn off power to the main unit
- 2) Remove the oven from side platform of the main unit
- 3) Unscrew moveable mirror from the sample and remove temperature sensor from the oven
- 4) Twist M4 screw into the sample and pull the sample out of the oven
- 5) Cool the oven (blow air) until room temperature is reached.
- 6) Install another sample following the steps in 5.1
- 7) Alignment optical path again.
- 8) Start another cycle of measurement.
- 9) Turn off power when experiment is complete.

Potential data chart:

Sample	Length l_0 (mm)	Temperature (°C)		Interference Fringe Change N	Sample Length Change $\Delta l = \frac{N \times 632.8}{2}$ (nm)	Linear Expansion Coefficient a ($\times 10^{-6}/^\circ\text{C}$)
		t_0	t			
Al						
Cu						
Steel						

CAUTIONS: do not heat the oven prior to experiment, since it will take time to cool down to room temperature. Before heating, wait a while to observe stable temperature display and avoid holding the sample directly in hand to avoid body heat transferred to the sample.