Birzeit University

Physics department

Physics 211

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Experiment name: the thermal expansion coefficient of brass

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Abstract:

In this experiment ,the thermal expansion coefficient of a rod of brass is determined by measuring the increase in the length of the rod with the increase of temperature and the use of the relation

 L=L0+(1+ α (T-T0))

Results:

α1=(1.8±0.2) X10-5 (1/c0)

α2= (2.10 ± 0.15)X10-5 (1/c0)

α(avg)= (1.97±0.19) X10-5 (1/c0)

Theory:

Thermal expansion is the tendency of matter to change in volume in response to the change in temperature.

 When a substance is heated its molecules is pushed further a part and usually maintains a higher separation than it would have in the normal temperature , some materials also contract by the increase of temperature but such materials are rare ,the degree of expansion divided by the change in temperature is called the materials coefficient of thermal expansion and generally varies with temperature 1.

The linear thermal expansion coefficient ,CLTE (α), is calculated as :

 α= ∆L/(L0\*∆ T)

L0 original length of the sample .

∆L change in length of sample.

∆T temperature change during the test

Procedure:

The apparatus used is of a brass rod fixed at one end and the other end is allowed to expand against a back of a mirror which is held by a rubber band ,and a laser light which is reflected from the mirror to a metric measuring instrument (in our experiment a ruler was used) to indicate the distance of the mirror from that of the laser source .

First part :

calibration :

the length of the rod from the point of clamping to the point at its touching the mirror was measured this was taken to be L0

for calibration a few slips of known thickness were used to find the reflection given at a certain thicknesses measure the thickness of the ten slips and then divide that by ten to find the thickness of a single slip .

second part :

by the work done by the resistance of the coil wire the brass rod is heated by the electricity until no more expansion is noticed ,

for every five degrees the temperature increases a reading is recorded for the change in the length .and same thing is done upon cooling as a five degrees decline a reading is to be recorded.

Data and calculation:

Part1:

Calibration curve:

|  |  |
| --- | --- |
| T (m) | scale (m) |
| 0 | 0.142 |
| 0.000126 | 0.147 |
| 0.000252 | 0.151 |
| 0.000378 | 0.155 |
| 0.000504 | 0.16 |
| 0.00063 | 0.164 |
| 0.000756 | 0.169 |
| 0.000882 | 0.171 |
| 0.001008 | 0.176 |
| 0.001134 | 0.181 |
| 0.00126 | 0.186 |

Calibration curve .

Part 2 L vs T :

HEATING:

|  |  |  |  |
| --- | --- | --- | --- |
| T (c0) | scale heating (m)  | T(m) | L (m) |
| 22 | 0.145 | 5.47030201825349E-05 | 0.502054703020183 |
| 24 | 0.146 | 8.34940834365009E-05 | 0.502083494083437 |
| 26 | 0.147 | 1.12285146690467E-04 | 0.502112285146690 |
| 28 | 0.148 | 1.41076209944433E-04 | 0.502141076209944 |
| 35 | 0.15 | 1.98658336452365E-04 | 0.502198658336452 |
| 40 | 0.152 | 2.56240462960297E-04 | 0.502256240462960 |
| 45 | 0.154 | 3.13822589468229E-04 | 0.502313822589468 |
| 50 | 0.154 | 3.13822589468229E-04 | 0.502313822589468 |
| 53 | 0.155 | 3.42613652722195E-04 | 0.502342613652722 |

L=L0+(1+ α (T-T0))

L vs T,L=L0+L0αT-L0αT0

Slope= α L0, Y-intercept=L0-L0αT0

α 1= Slope/ L0= 0.0000092/0.502=1.83X10-5 (1/c0)

∆ α/ α= ∆slope/slope +∆L0/L0

∆ α=2.3X10-6 (1/c0)

COOLING:

|  |  |  |  |
| --- | --- | --- | --- |
| T (c0) | scale cooling (m) | T(m) | L (m) |
| 22 | 0.142 | -3.16702E-05 | 0.501968 |
| 24 | 0.143 | -2.87911E-06 | 0.501997 |
| 26 | 0.143 | -2.87911E-06 | 0.501997 |
| 28 | 0.144 | 2.5912E-05 | 0.502026 |
| 35 | 0.146 | 8.34941E-05 | 0.502083 |
| 40 | 0.148 | 0.000141076 | 0.502141 |
| 45 | 0.149 | 0.000169867 | 0.50217 |
| 50 | 0.151 | 0.000227449 | 0.502227 |
| 53 | 0.155 | 0.000342614 | 0.502343 |

Slope = αL0, Y-intercept=L0-L0αT0

α2= 0.0000105/0.502 =2.1X10-5 (1/c0)

∆α=1.5X10-6 (1/c0)

α(avg)= (1.97±0.19) X10-5 (1/c0)

**Results :**

α1=(1.83±0.2) X10-5

α2= (2.1 ± 0.15)X10-5 (1/c0)

α(avg)= (1.97±0.19) X10-5 (1/c0)

**Discussion of results:**

Theoretical value of the expansion coefficient is 1.9x10-5 1/c0 which is very close to the experimental value obtained .

Also a source of error is that while taking the data the observer should record both the temp and the scale which as he turns his head by mili seconds the observed scale would be not for the same exact temp he read since its already being increased by the coils work on the rod .

**Conclusion :**

The thermal expansion coefficient α= (1.97±0.19) X10-5 (1/c0)

 Of the Brass rod that’s in the department of physics at the university of Birzeit.

**References:**

* <http://en.wikipedia.org/wiki/thermal_expantion>
* <http://hyperphysics.phy-astr.gsu.edu/hbase/tables/thexp.html>