Materials and Methods

- At thermal equilibrium, the Fourier heat flow equation applied to the test sample becomes:

\[ \mathbf{Q} = \mathbf{R} \mathbf{G} \mathbf{T} \]

Where:
- \( \mathbf{R} \) = thermal resistance of the sample
- \( \mathbf{G} \) = heat flow transducer calibration factor
- \( \mathbf{T} \) = upper plate surface temperature
- \( \mathbf{Q} \) = heat flow transducer output
- \( \mathbf{R}_w \) = interface thermal resistance

- \( d \) = thickness of the sample

- The sample thermal conductivity, \( k \), is calculated from:

\[ k = \frac{d}{\mathbf{R}_w} \]

- Calibrate the 2022 using known references such as water, glycerol, and silicone fluid at the temperatures of interest.
- Find conductivities at 283, 285, 287, ..., 293, 295K.
- Find and compare thermal conductivities versus temperatures.
- Write piece-wise function to model both sides of phase shifts.
- Select the appropriate length of a bi-layer junction such that hexadecane shifts phase and creates rectifier

Results

- Temperature-dependent Thermal Conductivity of Hexadecane

\[ \text{Temperature (K)} \quad \text{Thermal Conductivity (W/mK)} \]

<table>
<thead>
<tr>
<th>Temperature (K)</th>
<th>Thermal Conductivity (W/mK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>272</td>
<td>0.110</td>
</tr>
<tr>
<td>277</td>
<td>0.210</td>
</tr>
<tr>
<td>282</td>
<td>0.310</td>
</tr>
<tr>
<td>287</td>
<td>0.410</td>
</tr>
<tr>
<td>292</td>
<td>0.460</td>
</tr>
<tr>
<td>297</td>
<td>0.510</td>
</tr>
<tr>
<td>302</td>
<td>0.550</td>
</tr>
</tbody>
</table>

- Hexadecane's \( \text{C}_{16} \text{H}_{34} \) has a melting point of 291K.
- The significant drop in conductivity slows down heat transfer.
- This will absorb heat and store it once a phase shift occurs.
- It may be possible to construct a bi-layer junction with hexadecane to act as a thermal-rectifier

Conclusions

The data shows that Hexadecane's thermal conductivity, \( k \), is temperature dependent and decreases significantly after a phase transition from solid to liquid. This drop in conductivity is due to differences in molecular structure.

While still in progress, a bi-layer junction could be constructed by using the properties of hexadecane to create a thermal rectifier – one-way heat flux transfer mechanism.

Lastly, the author is changed with the task to present real discovery and new knowledge from post-secondary academia and transfer that knowledge to a secondary environment. This goal can be accomplished via a Science, Technology, Engineering, and Mathematics (STEM) based lesson in a Project Based Learning [PBL] hybrid course of Algebra II / Physics offered at South Bend New Tech High School. The unit will cover topics such as linear functions, linear regression, piece-wise functions, proportional and function conversions, induction, radiation, convection, and heat energy transfer.

References

- Hexadecane to act as a thermal-rectifier
- It may be possible to construct a bi-layer junction with hexadecane that shifts phase and creates rectifier
- This will absorb heat and store it once a phase shift occurs.
- It may be possible to construct a bi-layer junction with hexadecane to act as a thermal-rectifier

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**For further information**

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