Pirani vacuum gauges are commonly used sensors for pressure measurements.

**Typical specifications:**
- Range: 100 mbar to 10⁻³ mbar
- Advantages: robust, simple in design, cheap in production
- Dimensions: 5x5x10 centimeters in height, width and length

**Advantages of miniaturization:**
- Small size
- Extended measuring range
- Low power consumption
- Batch processing

Reduced size and an extended measuring range enable new application fields like:

**Principle:** Conventional thermal conductivity vacuum gauges are based on measurements of thermal losses of electrical heated wires due to gas thermal conduction. Heat flux through the surrounding gas depends on pressure and should be maximized to achieve high sensitivity, whereas the heat losses by radiation and solid thermal conduction have to be minimized. A transfer of this measurement principle to silicon based micro-chips allow significant improvements in sensitivity and measuring range.

\[
\Delta T = \frac{N}{G_c + G_r + G_v} \quad (1)
\]

\[
U_s = \frac{1}{4} \beta \Delta T U_0 \quad (2)
\]

**Problems of analytical solutions:**
- Varying distances between membrane and walls (4, 6)
- Effective emissivity has to be measured (combination of A, B, C) (5)
- No temperature dependency for \(\lambda_{	ext{mem}}\) \(\lambda_{	ext{Si}}\) (T) is calculated by Wiedemann-Franz law (3)
- Energy accommodation coefficients used from literature (6)

**Figure 3:** Schematic setup of micropirani sensors

**Figure 4:** Wheatstone bridge

**Figure 5:** Schematic cross section showing problems in modeling thermal energy transport by gas molecules and radiation

**Figure 6:** Calculated and measured signal voltage \(U_s\) of the chip type VAC_03 in the fine and high vacuum range

**Table 2:** Chip dimensions for VAC_03

**Table 3:** List of parametric sweeps

**Computational details and specifications**

<table>
<thead>
<tr>
<th>COMSOL Version</th>
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<td>Hardware</td>
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<td>Mesh parts</td>
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<td>Minimum memory size for solving model</td>
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