

2.9.1 Heat capacity for solids: Einstein- and Debye-model

We will repeat the details of this discussion in a later chapter. Here we will just show some experimental findings which can be well understood within the Debye model and partly within the easier Einstein model.

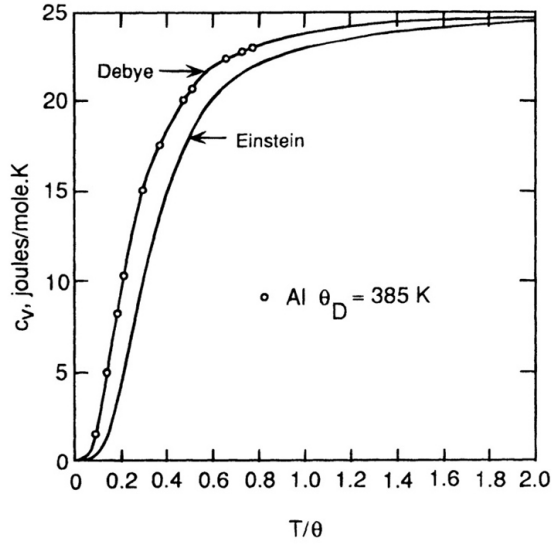


Figure 2.6: Comparison of measured C_V data and results using the Debye and Einstein model.

Fig. 2.6 shows a comparison between measured heat capacity data and corresponding points using the Debye and the Einstein model. Obviously the Debye model allows for a very good description of the measured data.

- The Einstein model assumes $3N$ oscillators each with the frequency ν . The capacity related to the vibrational energy is found to be

$$C_{vib} = 3R \frac{\left(\frac{\Theta}{T}\right)^2 \exp(\Theta/T)}{(\exp(\Theta/T) - 1)^2} \quad \text{with} \quad \Theta = \frac{h\nu}{k} \quad (2.25)$$

- The Debye model assumes $3N$ oscillators each with the frequency ν . The capacity related to the vibrational energy is found to be

$$C_{vib} = 9R \frac{T^3}{\Theta_D^3} \int_0^{\Theta_D/T} \frac{x^4 e^x}{(\exp(x) - 1)^2} dx$$

with $x = \frac{h\nu}{kT}$ and $\Theta_D = \frac{h\nu_{max}}{k}$ (2.26)

$$\text{For } T \ll \Theta_D : \quad C_{vib} = \frac{12\pi^4 R}{5} \frac{T^3}{\Theta_D^3}$$

$$\text{For } T \gg \Theta_D : \quad C_{vib} = 3R$$