2.2.5 Temperature dependence of the energy bandgap

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2.2.5 Temperature dependence of the energy bandgap

The energy bandgap of semiconductors tends to decrease as the temperature is increased. This behaviour can be better understood if one considers that the interatomic spacing increases when the amplitude of the atomic vibrations increases due to the increased thermal energy. This effect is quantified by the linear expansion coefficient of a material. An increased interatomic spacing decreases the potential seen by the electrons in the material, which in turn reduces the size of the energy bandgap. A direct modulation of the interatomic distance, such as by applying high compressive (tensile) stress, also causes an increase (decrease) of the bandgap.

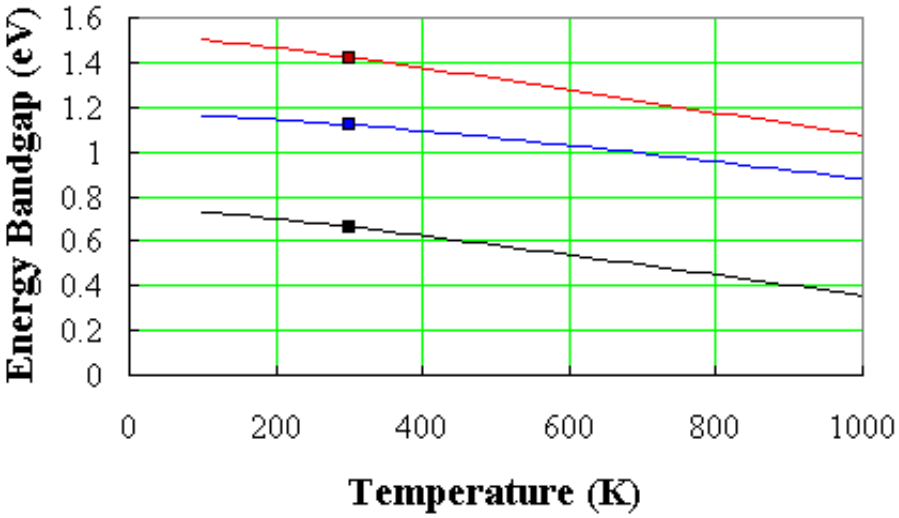
The temperature dependence of the energy bandgap has been experimentally determined yielding the following expression for E_g as a function of the temperature T:

$$E_g(T) = E_g(0) - \frac{\alpha T^2}{T + \beta} \quad \text{(f33)}$$

where $E_g(0)$, α and β are the fitting parameters. These fitting parameters are listed for germanium, silicon and gallium arsenide in the table below:

	Germanium	**Silicon**	**GaAs**
$E_g(0)$ [eV]	0.7437	1.166	1.519
α [eV/K]	4.77×10^{-4}	4.73×10^{-4}	5.41×10^{-4}
β [K]	235	636	204

A plot of the resulting bandgap versus temperature is shown in the figure below for germanium, silicon and gallium arsenide.



bandgap.xls - eband.gif

Fig.2.2.14 *Temperature dependence of the energy bandgap of germanium (bottom/black curve), silicon (blue curve) and GaAs (top/red curve).*

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