Bandgap Calculations of Semiconductor Materials using MATLAB

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Abstract :

This project manifests the calculation and results of band gaps of various semiconductor materials. The variation of band gaps with temperature have been plotted on MATLAB , screenshots of which have been attached in the document.
MATLAB is a programming language which allows manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages.
The direct relation of bandgap and temperature has been discussed in the paper.

Introduction :

The band gap of a semiconductor is the minimum energy required to excite an electron from the valence band into the conduction band where it can participate in conduction. The lower energy level of a semiconductor is called the "valence band" (EV) and the energy level at which an electron can be considered free is called the "conduction band" (EC).

Semiconductors are materials whose electronic properties are intermediate between those of metals and insulators. These characteristics are determined by the structure of the crystal, bonding characteristics, electronic energy bands, and also by the fact that unlike metals, a semiconductor has both the positive (hole) and the negative (electron) carriers of electricity whose densities can be controlled by doping the pure semiconductor with chemical impurities during the crystal growth.

Theoretical Modeling:

The formula used to calculate the bandgap energy is:

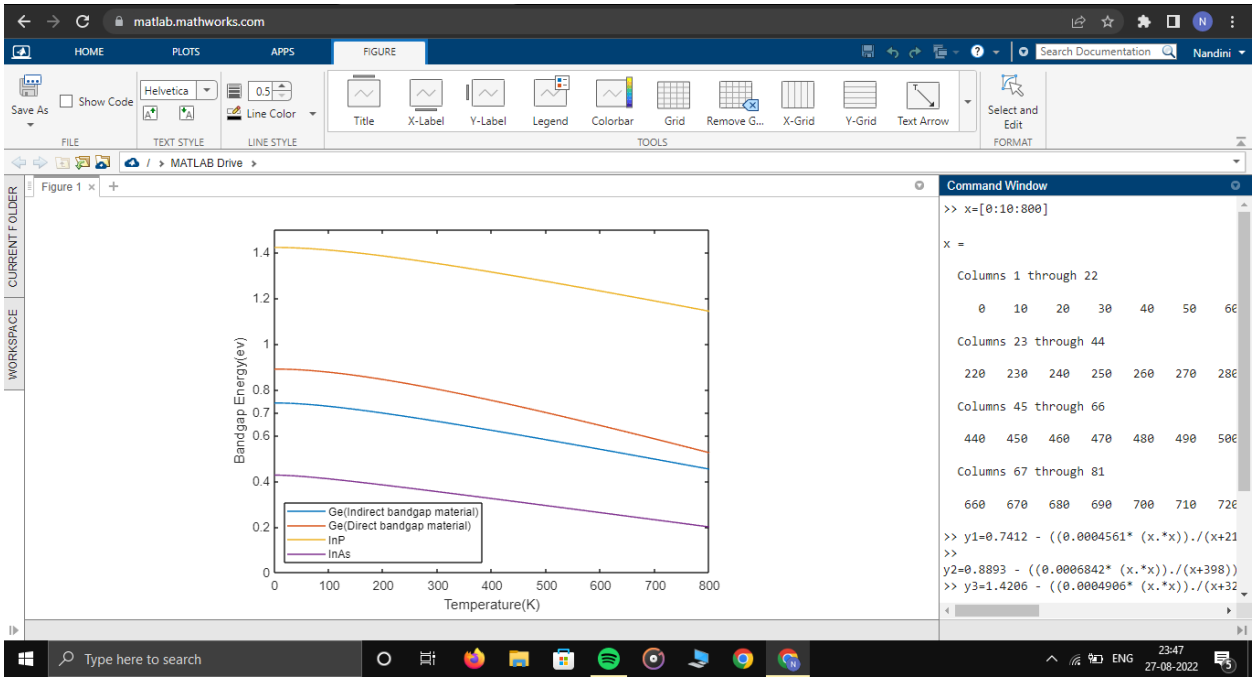
$$Eg(T)=Eg(0)+ \alpha T^2/(T+)$$

α and are material dependent constants.

For calculating the Bandgap energy following parameters are used.

Material	Eg(0) (eV)	α (eV/k) (*10^-4)	(k)
Ge (indirect) (direct)	0.7412	4.561	210
	0.8893	6.842	398
InP	1.4256	4.906	327
InAs	0.426	3.158	93

Results:



Conclusions:

From the above graph we can conclude that band gap energy is inversely proportional to the temperature.Direct and Indirect have also impact on bandgap energy.No change of momentum is there in direct semiconductor. For Ge,InP and InAs bandgap energy is 0.7412eV(indirect), 0.8893eV(direct),1.406eV, and 0.426eV respectively.

References:

- ➔ https://en.wikipedia.org/wiki/MATLAB