
2014-09-01_lecture

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```
In [1]: B_Si = 1.08e31 # K^-3 cm^-6
Eg_Si = 1.12 # eV (=1.602 x 10^-19 J)
KB = 8.62e-5 # eV / K

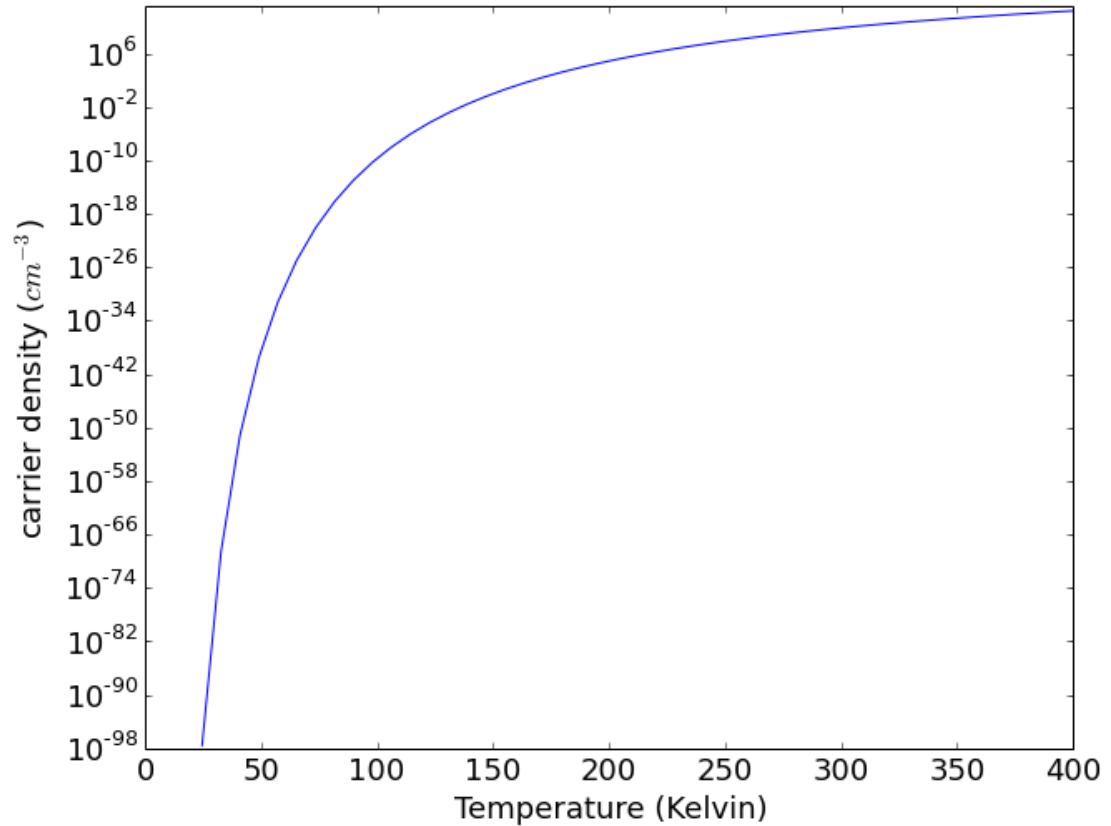
def ni2(T, B=B_Si, Eg=Eg_Si):
    return B * T**3 * exp(-Eg / (KB * T))
```

```
In [2]: def ann_temp(T=25, text='Room temp'):
        """Helper to add an arrow to room temperature."""
        ax = gca()
        x,y = (T, sqrt(ni2(T+272.15)))
        plot(x, y, 'o')
        ax.annotate(text, xy=(x,y), xytext=(x, y/5),
                    arrowprops=dict(arrowstyle='->',))
```

```
tempK = linspace(0, 400)

In [3]: semilogy(tempK, sqrt(ni2(tempK)))
        #hlines(5e22, tempK.min(), tempK.max(), 'r')
        ylabel('carrier density ($cm^{-3}$)')
        xlabel('Temperature (Kelvin)')
-c:6: RuntimeWarning: divide by zero encountered in divide
<matplotlib.text.Text at 0x30a99d0>
```

Out [3]:



In [4]:

```

commercial = (0, 85)
industrial = (-40, 100)
automotive = (-40, 125)
military = (-55, 125)

for tr,name in ((military, 'Military'),
               (automotive, 'Automotive'),
               (industrial, 'Industrial'),
               (commercial, 'Commercial')):
    tempC = arange(tr[0], tr[1], 1)
    tempK = tempC + 272.15

    semilogy(tempC, sqrt(ni2(tempK)), label='%s (%i to %i)' % (name, tr[0], tr[1]),
              linewidth=4)

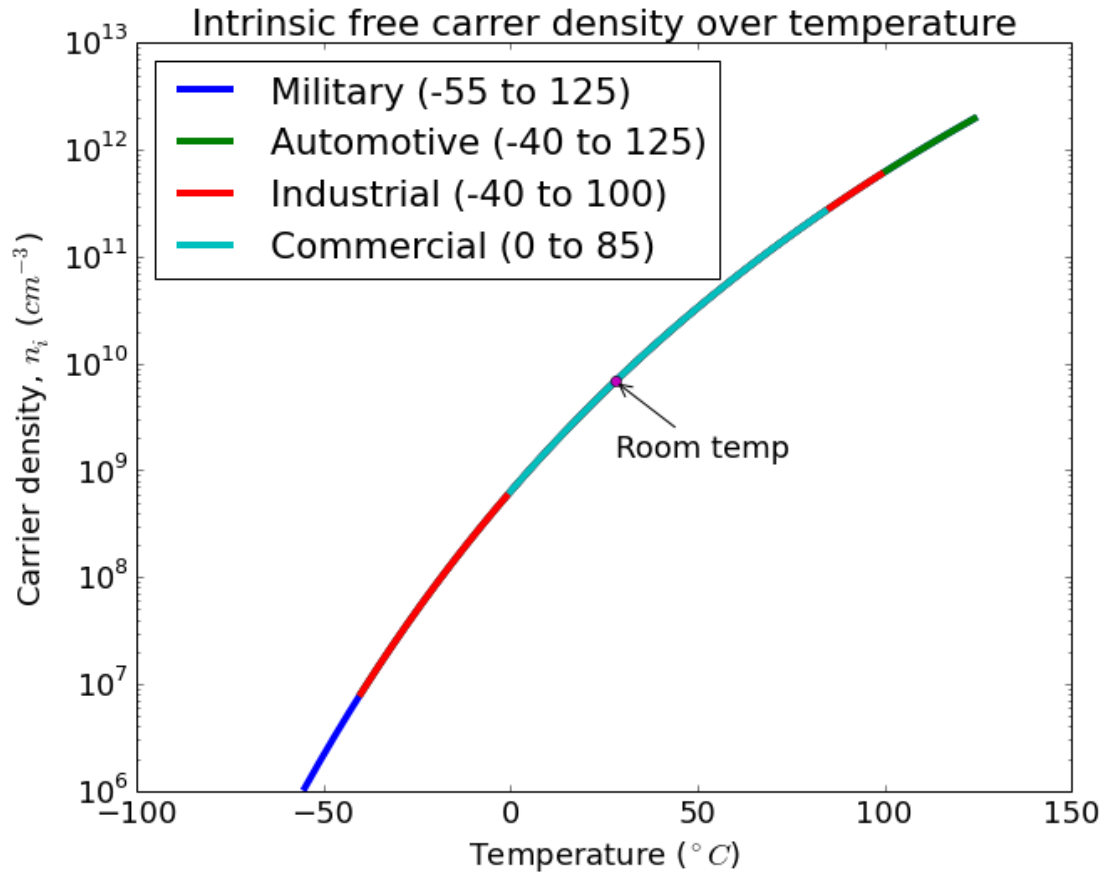
legend(loc='best')

ann_temp(300-272)

ylabel('Carrier density, $n_i$ ($cm^{-3}$)')
xlabel('Temperature ($^\circ$C)')
title('Intrinsic free carrier density over temperature')
<matplotlib.text.Text at 0x32d2710>

```

Out [4]:



1 THIS IS A HUGE RANGE !!!

In []: