2014-09-08_lecture

Dan White

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In [2]:
```
from pprint import pprint
phys_con = {
    'kB': 8.62e-5, # eV/K
    }

semi_con = {
    'Si':   {'Eg': 1.12, 'B': 1.08e31},
    'Ge':   {'Eg': 0.66, 'B': 2.31e30},
    'GaAs': {'Eg': 1.42, 'B': 1.27e29},
    }


def ni(T, semi='Si'):
    k = phys_con['kB']
    Eg = semi_con[semi]['Eg']
    B = semi_con[semi]['B']

    return sqrt(B * T**3 * exp(-Eg / (k * T)))
```

In [3]:
```
print '%.2e' % ni(300)
```

```
6.73e+09
```

1 In-class exercise

1.1 A pure Si crystal at 300K is doped with $10^{15}\text{atoms}/\text{cm}^3$ of phosphorus. Find the new electron and hole concentrations n and p.

$$n = \frac{(N_D - N_A) \pm \sqrt{(N_D - N_A)^2 + 4n_i^2}}{2}$$

and

$$p = \frac{n_i^2}{n}$$

In [4]:
```python
ND = 1e15
NA = 0

#old version, only use + solution
def np(ND, NA, T=300, semi='Si'):
    n = array(((ND - NA) + sqrt((ND - NA)**2 + 4*ni(T, semi)**2),
               (ND - NA) - sqrt((ND - NA)**2 + 4*ni(T, semi)**2))) / 2
    p = ni(T, semi)**2 / n
    return (n, p)


def np(ND, NA, T=300, semi='Si'):
    x = (abs(ND - NA) + sqrt(abs(ND - NA)**2 + 4*ni(T, semi)**2)) / 2
    y = ni(T, semi)**2 / x

    if ND > NA:
        n, p = x, y
    else:
        n, p = y, x

    return (n, p)

pprint(np(ND, NA))
```

```
(1000000000045231.0, 45231.022811462586)
```

In [5]:
```python
pprint(np(0,0))
```

```
(6725401312.4503155, 6725401312.4503155)
```

In [6]:
```python
ni(300)**2
```

Out [6]:
```
4.5231022813508428e+19
```

hw03 calculations

In [7]:
```python
pprint(np(3e17, 0, T=300))
```

```
(3.0000000000000013e+17, 150.77007604502802)
```

In [8]:
```python
pprint(np(3e17, 0, T=250))
```

```
(3e+17, 0.015097366344414)
```

In [9]:
```python
pprint(np(0, 6e18, T=300))
pprint(np(0, 6e18, T=200))
```

```
(7.5385038022514044, 6e+18)
(8.7970249867476468e-10, 6e+18)
```

In [9]:
```python

```