Nanoscale physics

Kinetic coefficients in the generalized model of electron transport within 2D semiconductor crystals

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When the crystal with created electric field, where the tension is $\vec{E}$ and the temperature gradien is $\nabla_{\vec{r}} T$, is placed in the magnetic field, where the induction vector is $\vec{B}$, electric current and heat flows with the appropriate current density $\vec{j}$ and heat-flow density $\vec{j}_q$ appear.

Those flows are described with such familiar generalized equations:

$$\vec{j} = (\sigma_{ik}(\vec{B}))\vec{E} - (\beta_{ik}(\vec{B}))\nabla_{\vec{r}} T, \quad \vec{j}_q = (\gamma_{ik}(\vec{B}))\vec{E} - (h_{ik}(B))\nabla_{\vec{r}} T$$

The tensors $(\sigma_{ik}(\vec{B})), (\beta_{ik}(\vec{B})), (\gamma_{ik}(\vec{B})), (h_{ik}(B))$ define important properties of semiconductor crystals. For $3D$ isotropic semiconductors these tensors depend on such functionality [1]:

$$J(i, j, \vec{B}, \mu^{\bullet}, T)_{G3D} = \int_0^{\infty} \left(\frac{\varepsilon}{kT} \right)^i \frac{u^j G(\varepsilon)}{1 + \left(u(\varepsilon)\vec{B}\right)^2} \left(-\frac{df_0}{d\varepsilon} \right) d\varepsilon,$$

where $f_0(\varepsilon)$ is Fermi-Dirac function, and $u(\varepsilon)$ i $G(\varepsilon)-$ familiar statistical physics functions [1]. For $2D$ semiconductors such functionality has the following meaning:

$$J(i, j, \vec{B}, \mu^{\bullet}, T) = J(i, j, \vec{B}, \mu^{\bullet}, T)_{G3D} \left(1 - \frac{1}{2d} \frac{J(i, j, \vec{B}, \mu^{\bullet}, T)_{G2D}}{J(i, j, \vec{B}, \mu^{\bullet}, T)_{G3D}} \right),$$

where d is $2D$ crystal thickness, and $G2D$ index means that the function $G(\varepsilon)$ is calculated for $2D$ crystals.

1. *Budzhak J.* The elements of statistical theory of semiconductor crystals kinetic properties // Technical News journal.-2012.-**1(35), 2(36)**.-P. 26-31.