Electron leh hole concept kha

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Thuhma

Tun tum chu class XII level ka lo ziak teh ang. Pawl XII kan zir lai khan mi dilchhut tak mai kha kan ni a. Semiconductor kha electron leh hole hmanga zirtirtute'n an hrilhfiah khan proton ni bawk si lo positive charge nei ve hole a lo lan khan kan han buai em em a. Zirtirtute kan tibuai hle a. Hriatthiam chu sawi loh a awih khan kan awih mai mai thei lo a ni. Thinrim tepin zirtirtute kan han zawt hial a ni. Mahse annin dawh thei takin min han hrilh a, tunah chuan hole mobility leh conductivity thlengin ka han teh ve ta a. A hlimawm thin khawp mai.

Energy band diagram atangin

Ka article pakhat schrodinger equation hmanga Pauli exclusion principle avanga energy chhunga band a awm dan kha kan chhiar theuh ka ring a. Mahse kha kha chu BSc level a ni a. In zir chhoh zel chuan nuam in ti hle dawn a ni a. A hnuaia tarlan ang hian insulator, metal leh semiconductor te kha an energy band hmanga hrilhfiah thin a ni a.

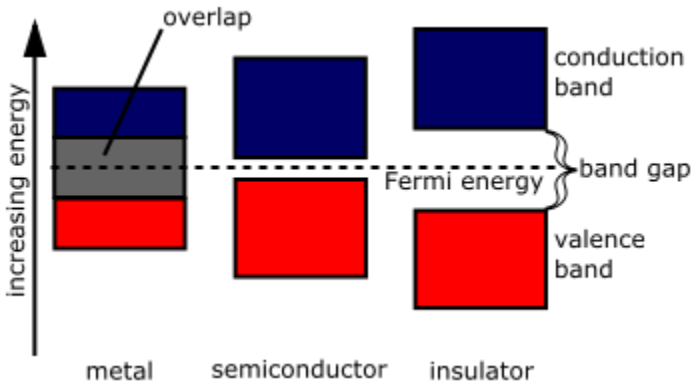

Figure 1: Energy band diagram (http://eng.thesaurus.rusnano.com/wiki/article853)

A hnuai ami valence band-ah khian electrons tam tak an awm a. Metal tan khian conduction band ah khian a chanve chin chiah ang velah electron an awm a. A chanve dang chu a ruak a. Electric field kan apply khan electron khan han awmna tur hmun ruak an nei ve ta a. Energy an han neih belh khan an han chho ve ta thin a ni. Insulator erawh chu valance band leh conduction band inkar hi a zau khawp mai a. Tin, conduction band-ah khian electron pakhatmah an awm lo a ni.

Diamond tan hian conduction leh valence band inkar khi 6 eV lai a ni a. Heti ang zat energy hi electron tan neih theih a har a, electric field kan pek hmangin chuti ang zat chakna a nei a nih chuan insulator chu a chhia ang a, chu chu insulator break down an tih kha a ni. Semiconductor tan khian valence band khi a dang ang thoin electron khana luah vek a. Mahse band pahnih inkar khi a tlem vet hung a ni. Mahse insulator angin conduction band-ah khian electron an awm lo ve tho a. Mahse an band gap inkar erawh a zim ve thung a. Germanium tan phei chuan 0.6 eV chauh a ni.

Entirnan Silicon kha ngaihtuah ta ila. Valence shell-ah electron pali an neih avangin an bul hnaia atom dang awmte nen convalent band an siam thei a. A hnuaia kan tarlan ang hian zero Kelvin ah chuan electron – te kha atom dang electron-te nen bond an siam a. Mahse lumna hmangin emaw energy kan pek chuan valence band atangin conduction band lamah electron kha awlsamtein an han chho thei ta a ni. Mahse valence band lamah khan hmun ruak a hnutchhiah thung a.

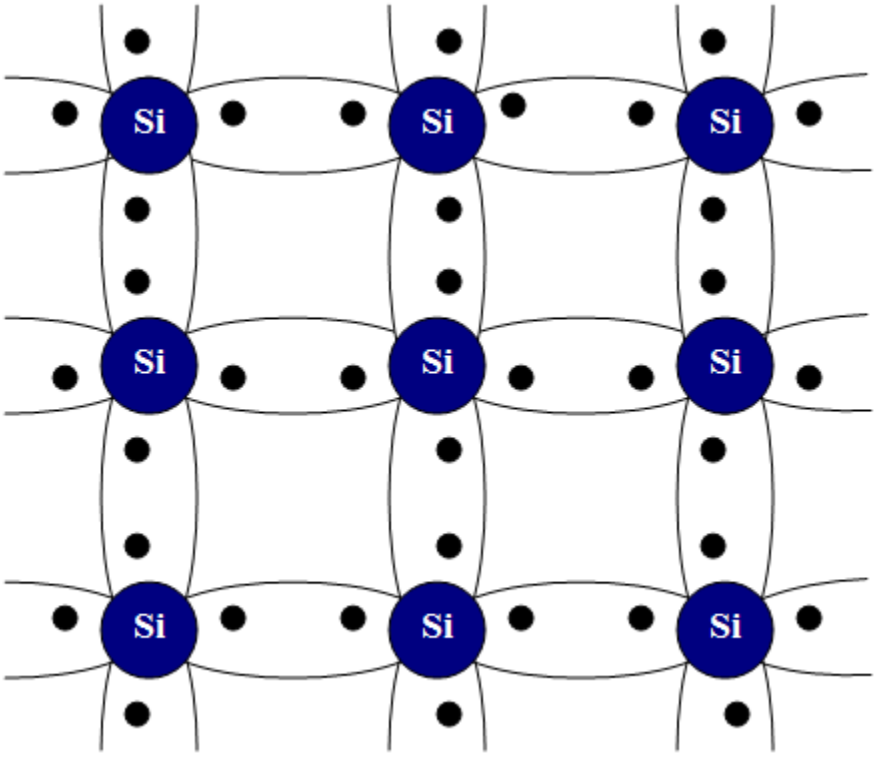

Figure 2: Covalent bond an siam dan (http://hyperphysics.phy-astr.gsu.edu/hbase/Solids/intrin.html)

Hmingthar lo lang ta e…

A chunga kan sawi ang khian electron chu conduction band lama a han chhoh khan valence band lamah hmun ruak a hnutchhiah a. Chumi chu hole kan ti ta kha a ni a. Chu chu lumna(heat) hmanga electron hole pair kan nei kan tih fo thin kha a ni ta a ni. A hnuaia figure 3na hi ngun taka kan en chuan Si atom khan a bond ami electron a hlauh chiah khan kha atom khan proton a

lo ngah ta zawk a. Khami atom a tawp kha a electron zawng zawng nen nucleus angin kan ngai thei ta a lo ni a.

Chumi awmzia chu Bohr's atomic model-a electron-in nucleus a hel ang chiah khan covalent bond atanga electro chhuak ta – free eletron kan tih khan atom chu nucleus a hel angin a lo hel ta a ni. Chumi avang chuan hole pawh kha positive charge nei angin kan ngai ta a lo ni a.

Pawimawh deuh mai pakhat chu electron chhuahna lai hi a bul hnai vel chu charge nei mah se crystal kha a zavai anga kan lak chuan a la neutral reng a ni. Tunah hian he Si crystal-ah hian electron field pe ta ila free electron kan neih kha a che dawn ta a ni. Chu electron chu conduction electron a lo ni dawn tihna a lo ni a.

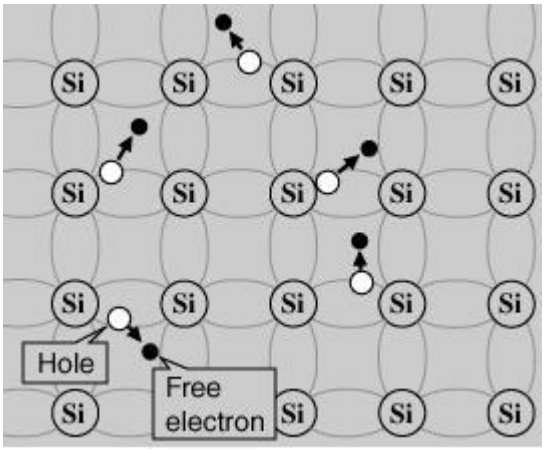

Figure 3: Covalent bond atangin electron an chhuak lai (http://hyperphysics.phy-astr.gsu.edu/hbase/Solids/intrin.html)

A nih leh electric field kan pek chuan holes chu eng tin nge a awm ve zel tak ang? A hnuaia figure 4na kan dah hi han en ta ila. Sawi tawh ang khan electron pakhat hlauh tawhtu Si atom kha positive charge a nih avangin hole khan a bul hnaia electron kha a hip thei a. Chuti ang zelin chumi hmun ruak – hole chuan a bul hnai ami electron kha a hip phei leh zel a. Chumi awmzia chu a lema kan entir ang hian electric field kan pek chuan electron khan hole hnawh khah zel avangin vei lamah an kal phei zel a, chutih lai chuan hmun ruak kha a awm zel avangin hole pawh kha dinglamah field hawina lamah a kal phei ve zel tihna a ni a.

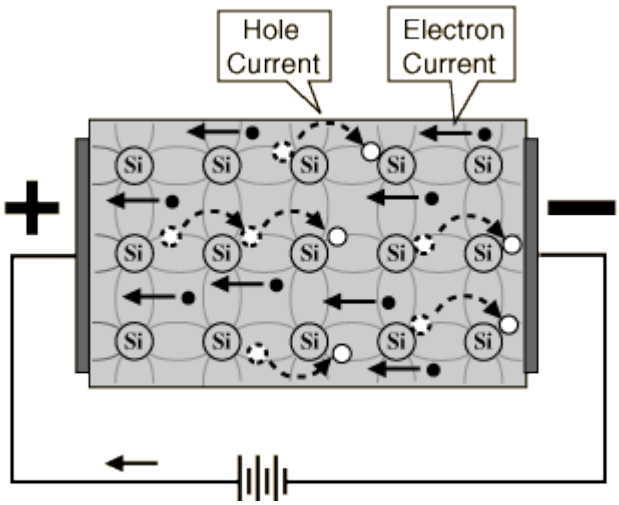

Figure 4: Electron leh hole kal dan (http://hyperphysics.phy-astr.gsu.edu/hbase/Solids/intrin.htm)l

A nihna takah chuan electron nei lo tu atom kha a insawn zel tihna a ni zawk a ni (atom insawn ni lovin electron awmlohnana hole kha a insawn a ni). Sawi ang khan a zavai anga kan lak dawn chuan he crystal charge hi a la neutral reng a ni. Amaherawhchu, hriat pawlh hauh loh tur thil a awm a. Electron hi conduction band lamah an han chho loa, valence band lamah zawk kan an che a ni. Mahse khi laia thermal (lumna) avanga electron lo chhuak khi chu conduction band lamah a che tla ve thung a ni.

Awle tunah chuan concept thar ilo sawi chhuak dawn teh ang. Conduction band-a electron khan current a siam a, chuti ang bawkin hole neitu atom kha positive a nih avangin electron a hip thei a, tin a bul hnai dang ami a hip zel avangin electron kha a tiche a. Chuvang chuan hole pawh hian electric current a siam ve kan ti thei ta a ni. Hei tak hi semiconductor danglamna a ni ta a. Metal leh insulator-ah chuan electron chuahin current a siam a, mahse semiconductor-ah chuan electron bakah hole hi charge carrier a ni. Chuvangin charge density pawh kan ziah dawn chuan heti hian kan ziak thin a:

$$j = qn_e\, v_e + \ qn_h\, v_h$$

Hetah hian q, n_e , v_e, n_h , v_h te hi electron charge, density, drift velocity leh hole density leh drift velocity te kha an ni a. Thermal energy kha I pek tam zel chuan electron hole pair kha a tam tulh tulh anga. Conduction band lamah electron pawh kha an tam zel dawn a, chuti ang zelin hole avanga electron kal pawh kha an tam dawn tihna a nih chu.

Kan sawi chinah chuan electron hole pair tih tam dan chu thermal energy hmangin a ni a. Electric field sang tak kan pek khan electron hole pair siam chhuah theih bawk a chu chu field emission an tia. Tin, eng (light) hmanga semiconductor kan chhun chuan a frequency kha band gap aia a san chuan EHP kan siam chhuak thei bawk a. Mizorama kan hman thin solar cell zawng zawng pawh hi a hnathawh dan dan chu heti ang vek hi a ni a. Tin, thermal energy kan pek khan atom-te kha an vibrate thei a, an bond thui zawngte a lo danglam ta a. Chumi avang chuan atom chuan an bond ami electron chu an hlauh thei a ni.

Metal tan chuan temperature a san zel khan resistivity a sang tulh tulh a ni tih kan hre teuh a. A sat poh leh current pawh a hniam dawn tihna a ni a. Amaherawhchu, semiconductor-ah hi chuan temperature a san poh leh resistivity a hniam zel a. Chumi awmzia chu electron kha an tam tulh tulh tihna a ni a. A letling daih a ni.

Extrinsic semiconductor

Tunah chuan phosphorus atom lo nei ta ila. Phosphorus hian atomic number 15 a nei a. A nih chuan valence electron 5 a nei tihna a ni a. Silicon atom chhungah chuan phosphorus atom chu dah ta ila. Mahse tam tak dah theih a ni lo a. Silicon atom 10^6 zat zelah phosphorus atom pakhat zel kan dah tur a ni a. A hnuaia figure 5na lema kan entir ang khuan Phosphorus atom-a electron palite chuan Silicon atom dang palite nen bond an siam anga. Mahse pakhat kha a chuang ta keuh a ni. Awle tunah chuan Phosphorus atom chu positive charge a lo ni tawh dawn a. Bohr’s

atomic model ang tho khan electron chuang bang khan chu phosphorus atom chu a hel veleh thung dawn a ni.

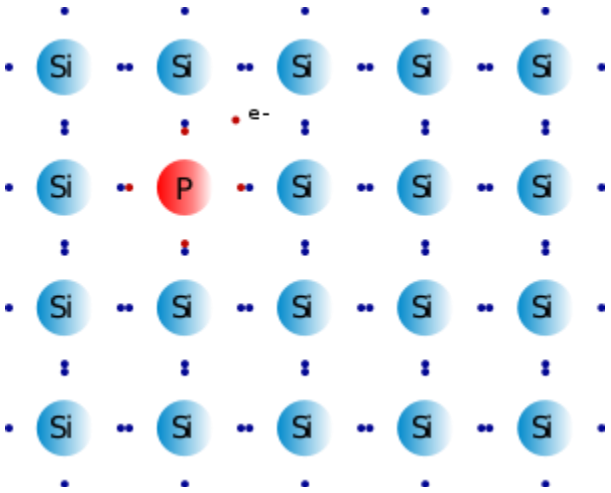

Figure 5: n type semiconductor (http://pediaa.com/difference-between-p-type-and-n-type-semiconductor/)

Mahse pawimawh deuh mai pakhat chu helaia electron hi duh duhin a che nghal ringawt lova. Phosphorus atom hian a la phuar bet reng a ni. A chhan chu energy kha Bohr's atomic modelah khan a quantize vang a ni a. Amaherawhchu, awlsawmtein a lak hran theih a. Chumi awmzia chu ionization energy a tlem viau tihna a nih chu. Zero kelvin-ah a energy kan chhut chuan a hnuaia figure 6naa kan tarlan dan ang hian phosphorus atom avanga electron lo awm chuan conduction band bul lawkah energy level a nei a. Chumi awmzia chu energy level thar a lo awm tihna a ni a. Chu chu donor level an ti bawk a ni.

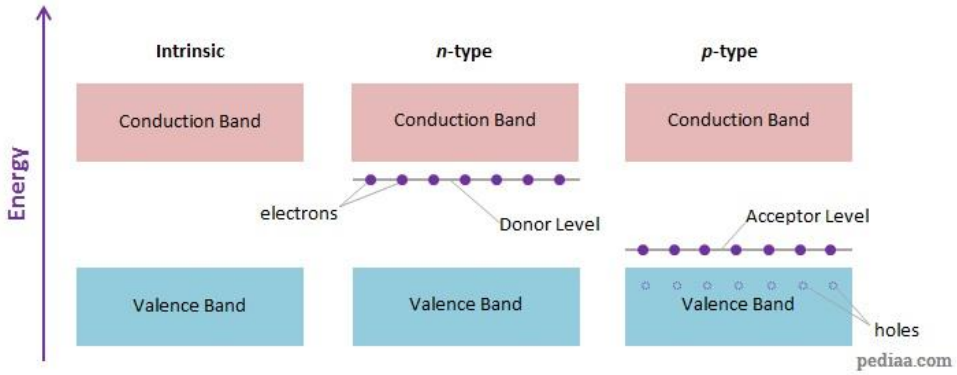

Figure 6: Energy band diagram extrinsic semiconductor tan (http://pediaa.com/difference-between-p-type-and-n-type-semiconductor/)

Zawhna pawimawh tak pakhat chu engah nge valence band-ah hian electron energy a continuous a mahse donor level hi pakhat chauh a nih tih hi a ni. Hei hi a chhanna chu phosphorus atom kha tlemte bak kan dah loh avang khan energy a tam thei loa, tin sawi tawh angin ionization energy avanga energy level thar nei ta kha a ni a. Chuvangin energy danglam hrang hrang kha a nei thei lo a ni.

Awle tunah chuan zero kelvin atangin temperature han pe ta hlek la. Khi laia donor level khi conduction band nen a inhnaih em avangin a hma aiin electron khan conduction band lamah a han kai awlsam tawk zawk dawn a. Mahse hemi-ah hi chuan valence band lamah hole pakhatmah a siam lo thung dawn a ni. Heti ang semiconductor hi n – type semiconductor tia a hming an vuah kha a ni a.

Tunah chuan boron atom pakhat lo nei veleh ta ila. Figure 7naa kan entir ang khian boron atom-a electron pathumte khan Silicon atom pathumte nen bond nan an hmang ang a. Pakhat-ah chuan hole a awm dawn ta a ni.

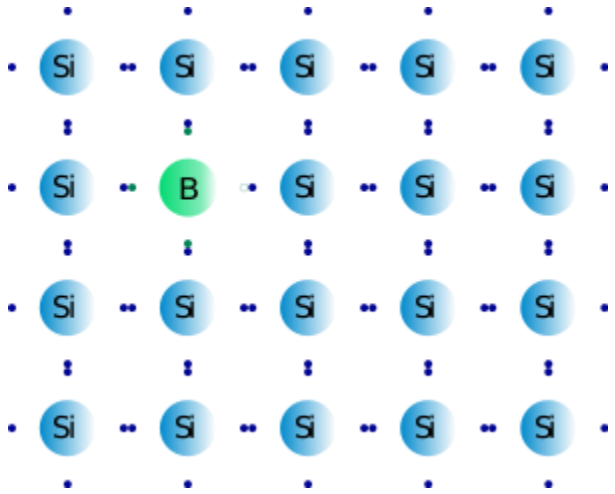

Figure 7: p type semiconductor (https://en.wikibooks.org/wiki/Semiconductor_Electronics/Semiconductor/Doping)

Electron ang chiah thoin mahse a letling zawngin energy erawh a kal thung a. Figure 6naa kan entir ang khian energy band diagram-ah khan energy level thar a lo awm ta a. Chu chu acceptor level an ti ta a ni. A chhan chu electron kha a lo pawm theih reng vang a ni. Energy kan pek khan electron chuan hole awmna hmun khi a han chuh ta vat ang a. Chuti chuan valence band-ah hmun ruak a siam teuh dawn ta a. Chumi hmun ruak chu hole kan tih tho kha a la ni zel a. Hole kan tipung tihna a nih chu. A hmingah pawh p – type semiconductor kan ti a. Electric current siamtu – charge carrier pawh kha hole a ni ta zawk a ni.

Tihtawp ang

Awle, tunah chuan titawp leh ta rih mai ila. He article hian a tum ber chu hole nihna awmzia, a hming lo chhuah dan sawifiah a ni a. Sawi tawh angin covalent bond-a electron kha a chhuah khan bond neitu atom kha positive charge a lo ni ta a. Bohr’s atomic model –a electron-in

nucleus a hel angin chu positive charge atom chu nucleus anga ngaiin electron chuan a hel ve ta thung a ni. Remchang hmasa berah p – n junction kha kan lo ziak leh dawn nia.