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TURLI SIMMETRIYAGA EGA BO'LGAN QATTIQ JISMLAR KRISTALL PANJARASI

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ANNOTATSIYA

Qattiq jismlar tuzilishi, tarkibi, ularni tashkil etgan zarralari orasidagi o'zaro ta'sir kuchlari, mexanik elektr, magnit, optik va boshqa xossalari o'rganilgan.

Kalit so'zlar: *kristall, amorf jismlar, briliyuen zonasi, kristall panjara.*

АННОТАЦИЯ

Изучаются строение и состав твердых тел, силы взаимодействия между составляющими их частицами, механические, электрические, магнитные, оптические и другие свойства.

Ключевые слова: *кристалл, аморфные тела, алмазная зона, кристаллическая решетка.*

ABSTRACT

The structure and composition of solids, the forces of interaction between the particles that make them up, mechanical, electrical, magnetic, optical and other properties are studied.

Keywords: *crystal, amorphous bodies, diamond zone, crystal lattice.*

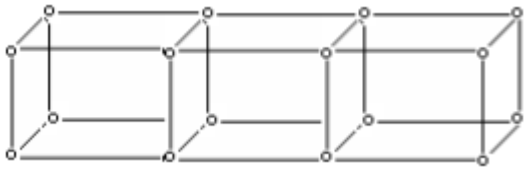
KIRISH

Qattiq jismlar tuzilishi, tarkibi, ularni tashkil etgan zarralari orasidagi o'zaro ta'sir kuchlari, mexanik elektr, magnit, optik va boshqa xossalari jihatidan turli guruhlarga bo'linadi. Masalan, elektr xossalari bo'yicha qattiq jismlar yaxshi o'tkazgichlar (metallar), yarimo'tkazgichlar va dielektriklar guruhlarini tashkil qiladi. Magnit xossalari jihatidan esa diamagnit, paramagnit, ferromagnit, antiferromagnit va ferritlar deb ataladigan qattiq jismlar turlari mavjud. Qattiq jismlar ularni tashkil qilgan zarralarning joylashish tartibiga asoslanib kristal va amorf jismlar guruhlariga ajraladi. Amorf jismlarni (masalan, shishani) tashkil qilgan atomlar (ionlar, molekulalar) ning joylashishida qat'iy bir tartib yo'q. Bundan ularning fazalarini -

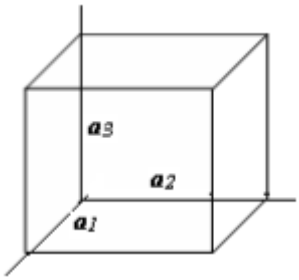
o'zgartirishda, (masalan, suyuqlanishda) qat'iy o'tish nuqtalari (suyuqlanish temperaturalari) mavjud bo'lmasligi kelib chiqadi: amorf jismlar bir holatdan ikkinchi xolatga o'zluksiz o'tib turadi. Ammo, kristall jismlarni tashkil qilgan atom(ion, molekula) lar joylashishida muayyan tartib mavjud: ma'lum yo'nalishlarda har qanday ikki qo'shni atom oralig'i bir xil. Shuning uchun ham kristall holatdagi qattiq jismlarning fazalari o'zgarishi (suyuqlanish, qotish va hokazo) qat'iy muayyan temperatura va bosimlarda sodir bo'ladi.[1-8]

MUHOKAMA

Mutloq nol temperaturada kristall atomlarining (masalan; uni tashkil qiluvchi har qanday zarralar)ning markazlari bir-biri bilan tutashtirilsa, fazoviy panjara hosil bo'ladi, uni kristall panjarasi deyiladi (1-rasm). Demaq kristallarda atomlarning joylashishi fazoviy davriylik (yoki translyatsion simmetriya) xossasiga ega. Har qanday kristallda bir tekislikda yotmagan uchta asosiy yo'nalish (bosh yo'nalishlar) bo'ladi: bu yo'nalishlarda bir xil o'rindagi (ekvivalent vaziyatdagi) ko'shni atomlar (ionlar, molekulalar) orasidagi masofalar $\vec{a}_1, \vec{a}_2, \vec{a}_3$ vektorlar orqali belgilanadi. Cheksiz kristall panjarasini har bir a_i vektor yo'nalishida ularga karrali masofaga siljitish kristall panjarasi vaziyatini o'egartirmaydi. Shuning uchun $\vec{a}_1$, (i = 1,2,3. . .) vektorlar asosiy yoki masshtab vektorlar yoki translyatsion davrlar deyiladi.



1-rasm. Kristall panjara tuzilishi

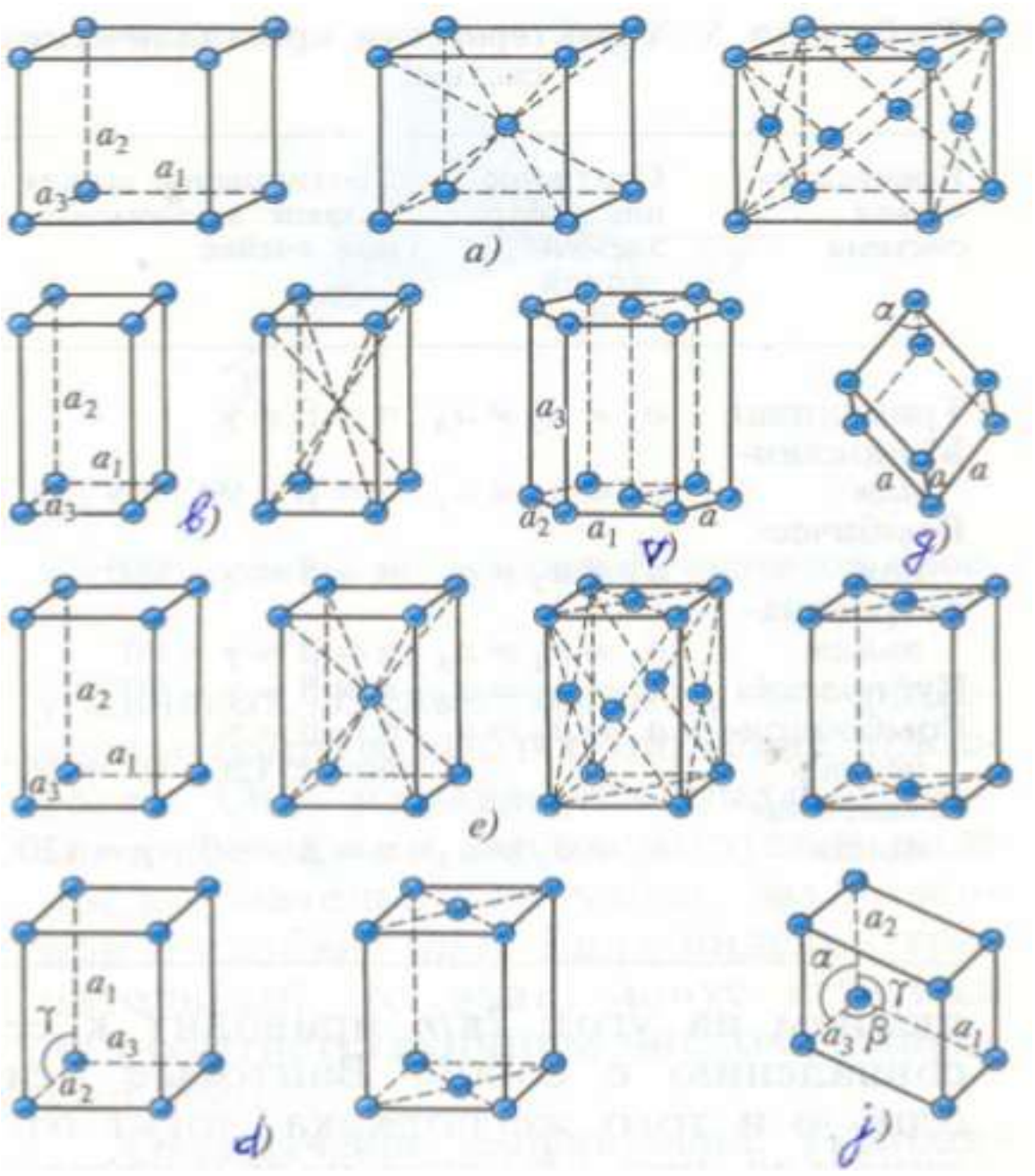


2-rasm. Elementar yacheyka

Shu uchta a_i vektorlar ustiga qurilgan parallelepiped eng kichik katak (elementar yacheyka) deyiladi (2-rasm). Ravshanki, bunday eng kichik katakning hajmi $V_0 = \vec{a}_1\left[\vec{a}_2, \vec{a}_3\right]$ o'ladi. Kristall panjarasida atomlarning markazlari joylashgan nuqtalar-tugunlar, ular orasidagi soha tugunlararo soha deb ataladi. [9-18]

NATIJALAR

Har qanday murakkab fazaviy panjara sodda panjaralarda (Brave panjaralarida) tuzilgan bo'ladi (3-rasm). Brave panjaralari geometrik jihatdan mumkin bo'lgan sodda panjaralar bo'lib, ularning soni 14 ta.



3-rasm. Kristall panjaralar: a) kubik, b) tetragonal, v) geksagohal, g) romboedrik, d) rombik, e) monoklin, j) triklin

Ideal kristallning asosiy xossasi-fazoda atomlarning davriy joylashishidan quyidagi munosabat kelib chiqadi: agar cheksiz kristall

$$\vec{a}_n = n_1\vec{a}_1 + n_2\vec{a}_2 + n_z\vec{a}_3 \qquad (1)$$

vektor qadar ko'chirilsa, u o'z-o'ziga mos tushadi, bunda nj-butun sonlar. Ravshanki, koordinatalar funksiyasi bo'lgan barcha fizik kattaliklar kristallichida uch o'lchovli davriy funksiya bo'ladi. Bunda $\vec{r}$ va $\vec{r}+a_n$ vektorlar bilan belgilanadigan kristalldagi nuqtalarda mazkur kattaliklar bir xil qiymatga ega bo'ladi. Shuning uchun, masalan, elektrostatik potensialning davriylik sharti bunday bo'ladi:

$$V(r) = V(\vec{r}+a_n) \qquad (2)$$

Bu uch o'lchovli davriy funksiyani Fure qatoriga yoyib, ba'zi bir almashtirishlar bajarilgandan keyin, uni

$$V(r) = \sum_b V_b e^{i(\vec{b}\,\vec{r})} \qquad (3)$$

ko'rinishda ifodalash mumkin. (2) shartni (3) ifodaga tatbiq etib, vektorni aniqlash shartini topamiz:

$$\vec{a}\,\vec{a} = 2\pi g_1, \vec{a}\,\vec{a}_2 = 2\pi g_2, \vec{a}\,\vec{a}_3 = 2\pi g_3 \qquad (4)$$

bunda g1, g2, gz - butun sonlar. Bu (1.4) shartlar asosida $\vec{b}$ vektor quyidagi

$$\vec{b} = \vec{b}_g = g_1,\vec{b}_1 + g_2\vec{b}_2 + g_z\vec{b}_z \qquad (5)$$

ko'rinishda ifodalanadi. Bu yerda $\vec{b}_1, \vec{b}_2$ va $\vec{b}_3$ larni

$$\vec{b}_1 = 2\pi\frac{\left[\vec{a}_2\,\vec{a}_3\right]}{V_o} \qquad \vec{b}_2 = 2\pi\frac{\left[\vec{a}_3\,\vec{a}_1\right]}{V_o} \qquad \vec{b}_3 = 2\pi\frac{\left[\vec{a}_1\,\vec{a}_2\right]}{V_o} \qquad (6)$$

ko'rinishda tanlab olish kerak.Haqiqatan,

$$\vec{b}_i\,\vec{a}_i = \begin{cases} agar.i \neq k.bo'lsa, 0 \\ agar.i = k.bo'lsa, 2 \end{cases} \qquad (7)$$

Agar panjara $\vec{a}$, vektorlar asosida tuzilgan bo'lsa, bunday panjara to'g'ri panjara deyiladi va $\vec{a}$ vektor to'g'ri panjara vektori deb yuritiladi. aksincha, $\vec{b}_b$ vektorlar asosida tuzilgan panjara teskari panjara deyiladi va bu vektor teskari panjara vektori deb yuritiladi.

XULOSA

Uchta vektordan yasalgan parallelepiped teskari panjaraning eng kichik katagi

(elementar yachaykasu) deyiladi; uning hajmi quyidagi ifodadan aniqlanadi: Teskari panjara tushunchasining tatbiqiga misol sifatida Bregg-Laue qonunining tegishli ifodasini keltiramiz. Ma'lumki, kristall panjara rentgen nurlari uchun difraktsion panjara vazifasini bajaradi (rentgen nurlari λ to'lqin uzunligi kristall panjarasining $\vec{a}$ doimiysi tartibida bo'ladi). Kristallga $\vec{k}$ o'lqin vektori bilan aniqlanadigan rentgen nurlari tushayotgan bo'lsin. Bu holda interferentsion maksimumlar sharti quyidagi ko'rinishda bo'ladi:

$$\frac{1}{2}\vec{b}_g^2 + (\vec{b}_g \vec{k}) = 0 \qquad (8)$$

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