



INDIAN SCHOOL AL WADI AL KABIR

CLASS: XII	DEPARTMENT: SCIENCE 2020 -2021 SUBJECT : CHEMISTRY	DATE: 31.08.2020
HANDOUT	TOPIC: SOLID STATE	NOTE: A4 FILE FORMAT
NAME OF THE STUDENT:	CLASS & SEC:	ROLL NO:

Imperfections in solids

- Defects in solids are basically irregularities in the arrangement of constituent particles.
- Defects are of two types; *Point defects and line defects*.
- Point defects are the irregularities from ideal arrangement around a point or an atom in a crystalline substance.
- Line defects are the irregularities from ideal arrangement in entire rows of lattice points.

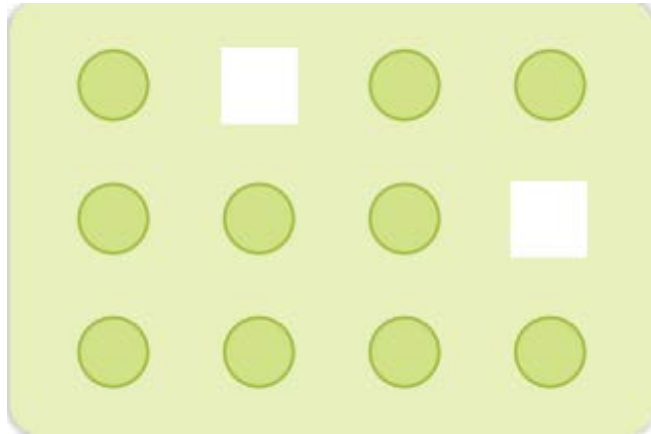
Types of point defects

(a) Stoichiometric defects

- They are also called intrinsic or thermodynamic defects.
- These defects that do not disturb the stoichiometry of the solid.
- For non-ionic solids, stoichiometric defects are of two types, vacancy defects and interstitial defects

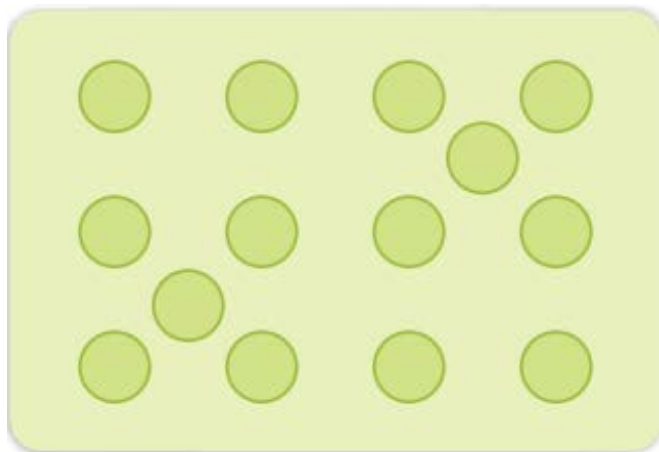
i) Vacancy defect

- ❖ **Vacancy defect** is developed when some of the lattice sites are vacant. This results in decrease in density of the substance.
- ❖ This defect can also be developed when a substance is heated.



ii) Interstitial defect

- ❖ **Interstitial defect** is developed when some constituent particles occupy an interstitial site. This defect increases the density of the substance.

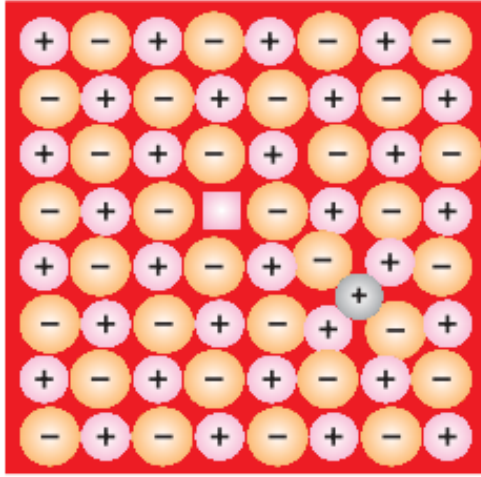


Stoichiometric defects in ionic solids

- **Ionic solids** must always maintain electrical neutrality.
- They exhibit defects as Frenkel and Schottky defects.

Frenkel defect

- This defect is shown by ionic solids in which there is large difference in the size of anion and cation. Usually cation is smaller.
- The smaller ion is dislocated from its normal site to an interstitial site. It creates a vacancy defect at its original site and an interstitial defect at its new location.
- Frenkel defect is also called dislocation defect. It does not change the density of the solid.
- Eg:- ZnS, AgCl, AgBr and AgI due to small size of Zn^{2+} and Ag^+ ions.

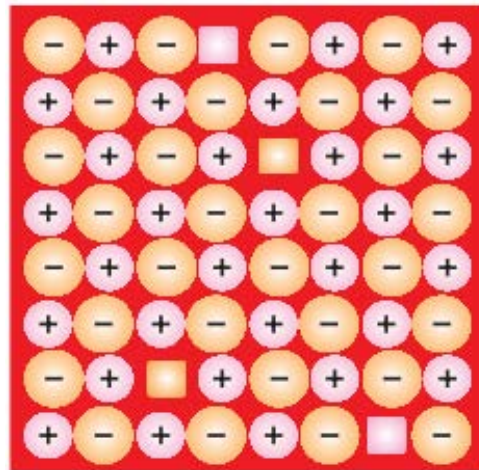


Schottky defect

- This defect is shown by ionic substances in which the cation and anion are of almost similar sizes.
- It is basically a vacancy defect in ionic solids. The number of missing cations and anions are equal so that electrical neutrality is maintained.
- Density of the substance decreases due to Schottky defect.

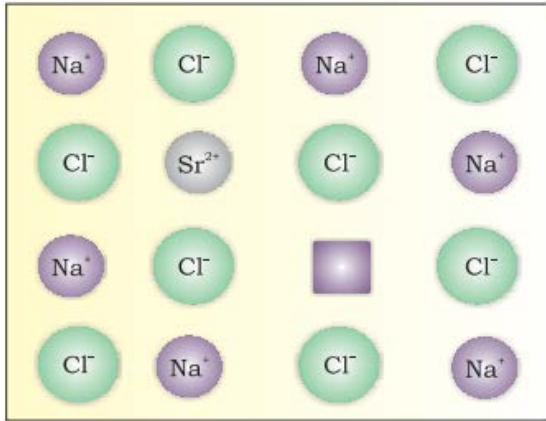
Eg:- NaCl, KCl, CsCl and AgBr.

- ❖ **AgBr shows both Frenkel as well as Schottky defects.**



(b) Impurity defects

- If molten NaCl containing a little amount of SrCl_2 is crystallised, some of the sites of Na^+ ions are occupied by Sr^{2+} .
- Each Sr^{2+} replaces two Na^+ ions. It occupies the site of one ion and the other site remains vacant.
- The cationic vacancies thus produced are equal in number to that of Sr^{2+} ions.



❖ Another similar example is the solid solution of CdCl_2 and AgCl .

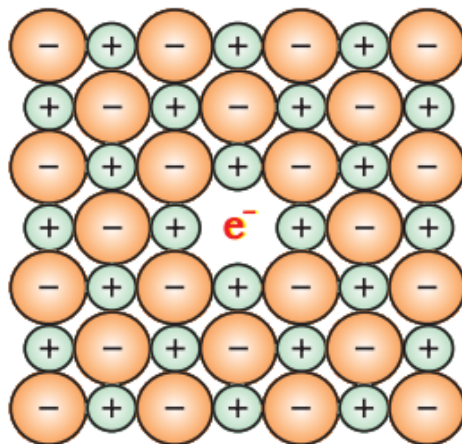
(c) Non-stoichiometric defects

- Due to these defects, stoichiometry of the substance is disturbed.
- Non-Stoichiometric defects are of two types: (i) metal excess defect and (ii) metal deficiency defect.

(i) Metal excess defect

a) Metal excess defect due to anionic vacancies

- When crystals of NaCl are heated in an atmosphere of sodium vapour, the sodium atoms are deposited on the surface of the crystal.
- The Cl^- ions diffuse to the surface of the crystal and combine with Na atoms to give NaCl . This happens by the loss of electrons by sodium atoms to form Na^+ ions.
- The released electrons diffuse into the crystal and occupy **anionic sites**. As a result, the crystal now has an excess of sodium.

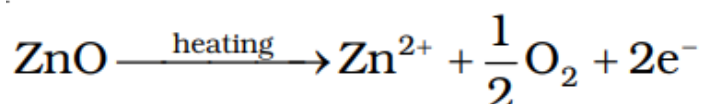


- **The anionic sites occupied by unpaired electrons are called F- centres** (German word Farbenzenter for colour centre).
- They impart **yellow** colour to the crystals of NaCl .

- The colour results by excitation of these electrons when they absorb energy from the visible light falling on the crystals.
- Excess of **lithium** makes LiCl crystals **pink** and excess of **potassium** makes KCl crystals **violet (or lilac)**.

b) Metal excess defect due to the presence of extra cations at interstitial sites

- Zinc oxide is white in colour at room temperature.
- On heating it loses oxygen and turns **yellow**.



- Now there is excess of zinc in the crystal and its formula becomes Zn_{1+x}O .
- The excess Zn^{2+} ions move to interstitial sites and the electrons to neighbouring interstitial sites.

(ii) Metal deficiency defect

- This defect arises when metal ions are present in different valency. A typical example of this type is FeO which is mostly found with a composition of $\text{Fe}_{0.95}\text{O}$.
- In crystals of FeO some Fe^{2+} cations are missing and the loss of positive charge is made up by the presence of required number of Fe^{3+} ions.

QUESTION

Analysis shows that nickel oxide has the formula $\text{Ni}_{0.98}\text{O}_{1.00}$. What fractions of nickel exist as Ni^{2+} and Ni^{3+} ions?

ANSWER

Let Ni^{2+} be x so that Ni^{3+} will be $0.98-x$.

The compound is electrically neutral.

Therefore, $2x + 3(0.98-x) - 2 = 0$

$x = 0.94$

% of $\text{Ni}^{2+} = \frac{0.94}{0.98} \times 100$

= **95.9 %**

% of $\text{Ni}^{3+} = 100 - 95.9$

= **4.1 %**