Welcome to 3.091

Lecture 19
October 23, 2009
Point & Line Defects
Taxonomy of Defects: 
Classify by Dimensionality

0-dimensional: point defects
1-dimensional: line defects
2-dimensional: interfacial defects
3-dimensional: bulk defects
Point Defects
- localized disruption in regularity of the lattice
- on and between lattice sites

1. Substitutional Impurity
- occupies normal lattice site
- dopant 😊, e.g., P in Si; B in C\textsubscript{diamond}
- alloying element 😊, e.g., Mg in Al; or Ni in Au
- contaminant 😣, Li\textsuperscript{+} in NaCl

2. Interstitial Impurity
- occupies position between lattice sites
- alloying element 😊, e.g., C in Fe; or H in LaNi\textsubscript{5}
- contaminant 😣, H in Fe
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Photo of the [Hope Diamond] removed due to copyright restrictions.
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3. Vacancy
- unoccupied lattice site
- formed at time of crystallization
- formed in service under extreme conditions
Image by [Cdang](https://en.wikipedia.org/wiki/Cdang) on Wikipedia.
3. Vacancy
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Monovacancies and divacancies in copper
Reanalysis of experimental data

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Abstract

The vacancy concentrations \( c_v \) in copper measured by means of the absolute technique (Hehenkamp et al., Phys. Rev. B 45 (1992) 1998) and those derived from positron lifetime studies (Kluin, Philos. Mag A 65 (1992) 1263) are reanalysed. Taking into account the results of quenching and annealing investigations the best fit to the temperature function of \( c_v \) is described by \( H_{1v}^S = 1.03 \text{ eV} \) and \( S_{1v}^0/k = 1.1 \) for the monovacancy formation enthalpy and entropy and a divacancy binding enthalpy and entropy of \( H_{2v}^S = -0.23 \text{ eV} \) (attractive interaction) and \( S_{2v}^0/k = 2.8 \), respectively. Accordingly, the divacancy concentration amounts to \( 1.5 \times 10^{-4} \) at the melting temperature. © 1999 Elsevier Science B.V. All rights reserved.

Keywords: Vacancies; Monovacancies; Divacancies; Copper

Point Defects in Ionic Crystals
- special issues associated with the need to maintain global charge neutrality

1. Schottky Imperfection
- formation of equivalent (not necessarily equal) numbers of cationic and anionic vacancies

2. Frenkel Imperfection
- formation of an ion vacancy and an ion interstitial

3. F-Center
- formation of an ion vacancy and bound electron
Image by Leyo on Wikipedia.
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Modeling dislocations in a soap bubble raft (Bragg and Nye)