3.091 Solid State Chemistry: Week 3

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Progress Update

Over the past week I have:

1. Gained a deeper understanding of how and why electron shells are filled the way they are (quantum numbers).
2. Learned about photoelectron spectroscopy.
3. Learned about average valence electron energy (AVEE)
4. Identified why ionic bonds form.

Quantum numbers

An atom's electrons have some values associated with them:

1. The principal quantum number n represents the energy level of a subshell of interest; an electron in $1s^1$ has $n = 1$, and an electron in $3s^2$ has $n = 3$.
2. The azimuthal quantum number $L = 0, 1, \cdots, (n-1)$ where the respective subshells are $s, p, d, f, \cdots$.

Quantum numbers (continued)

1. The magnetic spin numbers $m \in [-L, L]$ such that $m \in \mathbb{Z}$.
2. The electron spin number $\pm\frac{1}{2}$.

There can exist no electrons in an atom where all 4 quantum numbers are the same, by the Pauli Exclusion principle.

Photoelectron spectroscopy

We launch a photon of sufficiently high energy at an atom to dislodge all electrons from an atom, leaving a bare nucleus and electrons spat out at different kinetic energies.

Average Valence Electron Energy (AVEE)

A measurement used strictly for comparative purposes; returns the weighted average of the valence electrons count and subshell ionization energy; consider an atom with 2 electrons in the s orbital and 3 in the p orbital making up its valence shell.

$$\text{AVEE} = \frac{2I_s + 3I_p}{2 + 3} \tag{1}$$

Where $I_{s,p}$ are the ionization energies for the atom with Z protons; tables exist to find these values.

Ionic Bond Formation

The formation of ionic bonds is motivated by Coulomb's law; as 2 atoms approach eachother, enough energy may be released in forming a bond for them to "self-ionize" to achieve such a state. A chlorine atom is not automatically attracted to a sodium atom, but get them close enough and they can be pushed over the crest to a point of lower potential energy.