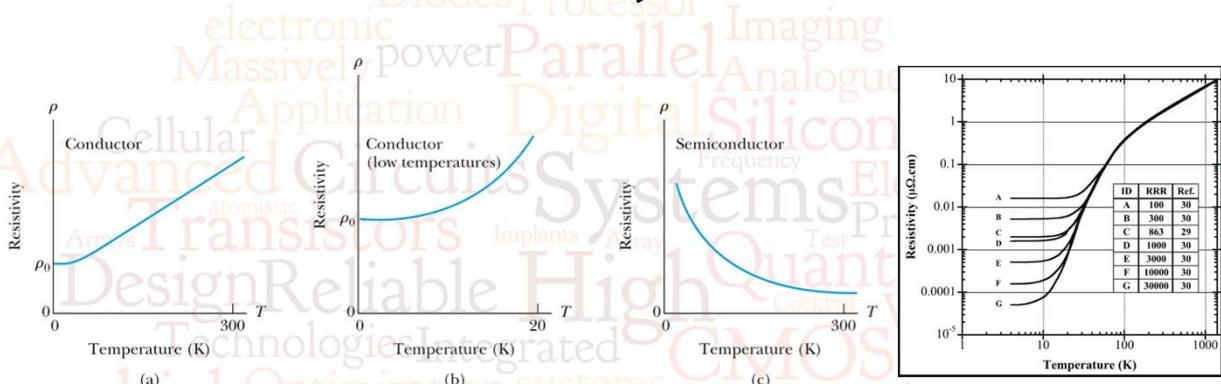


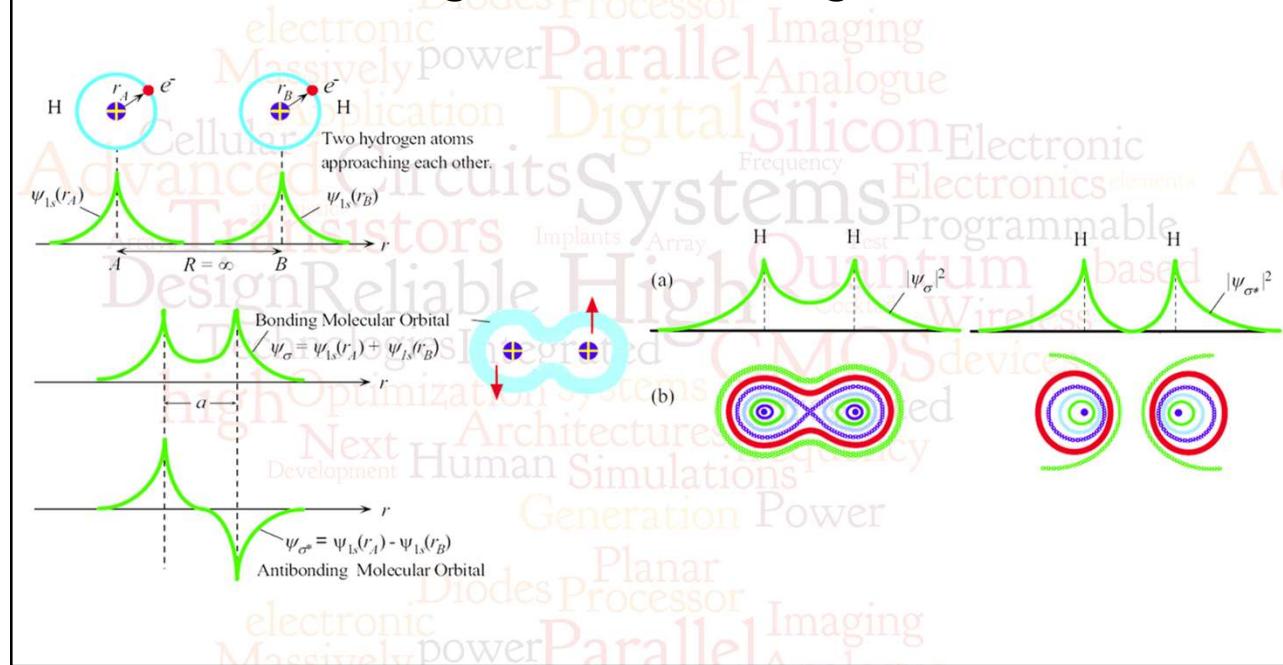
Band Theory of Solids



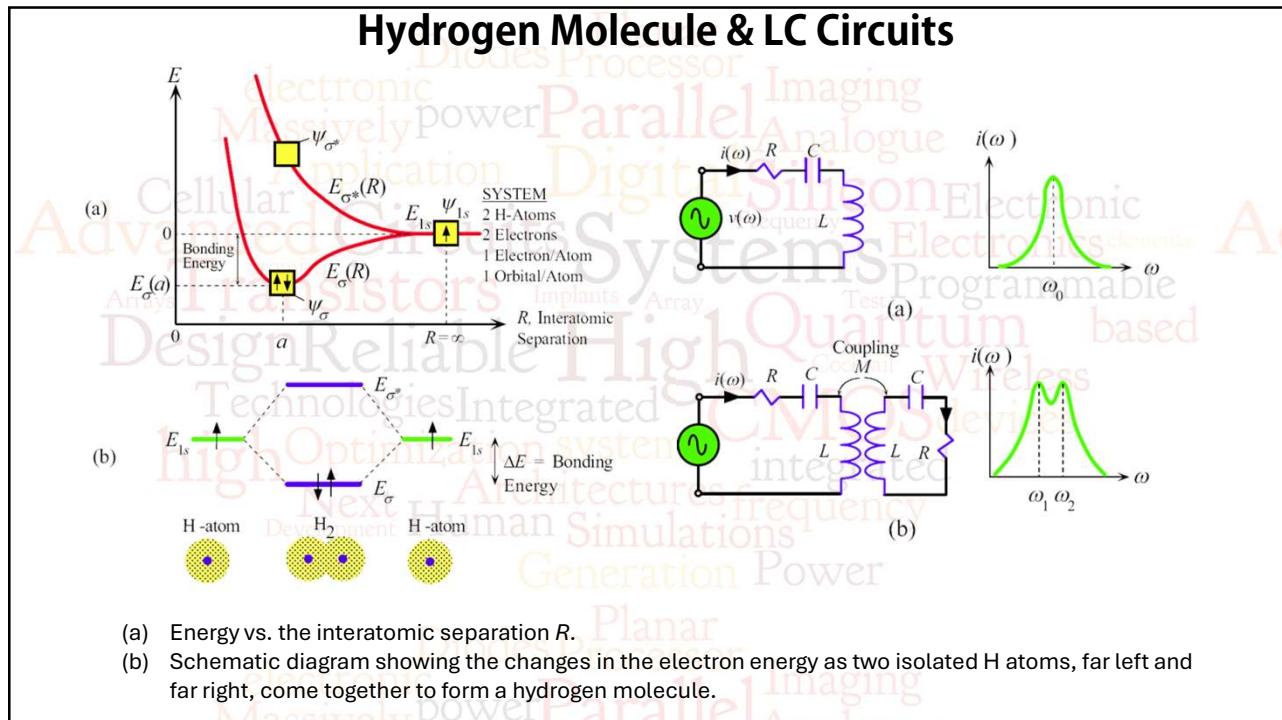
- In order to account for *decreasing* resistivity with increasing temperature as well as other properties of semiconductors, a new theory known as the **band theory** is introduced.
- The essential feature of the band theory is that the allowed energy states for electrons are nearly continuous over certain ranges, called **energy bands**, with forbidden energy gaps between the bands.

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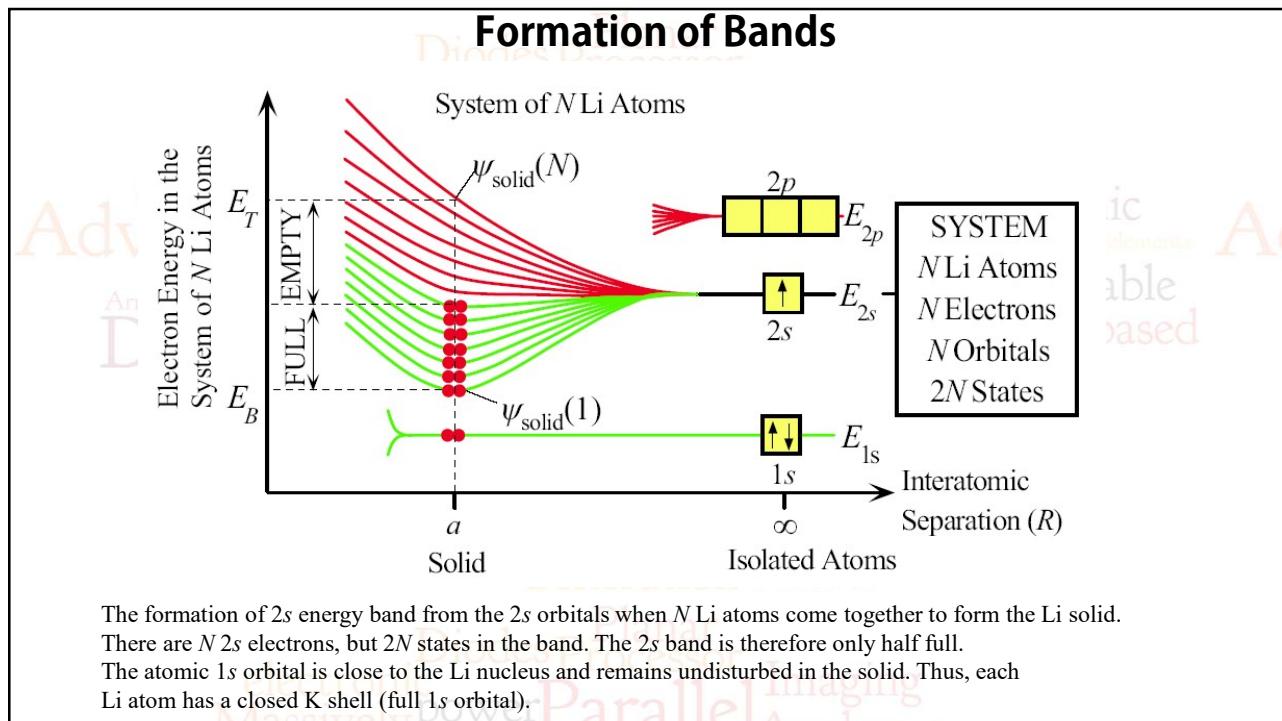
Bonding and Anti-Bonding Orbitals



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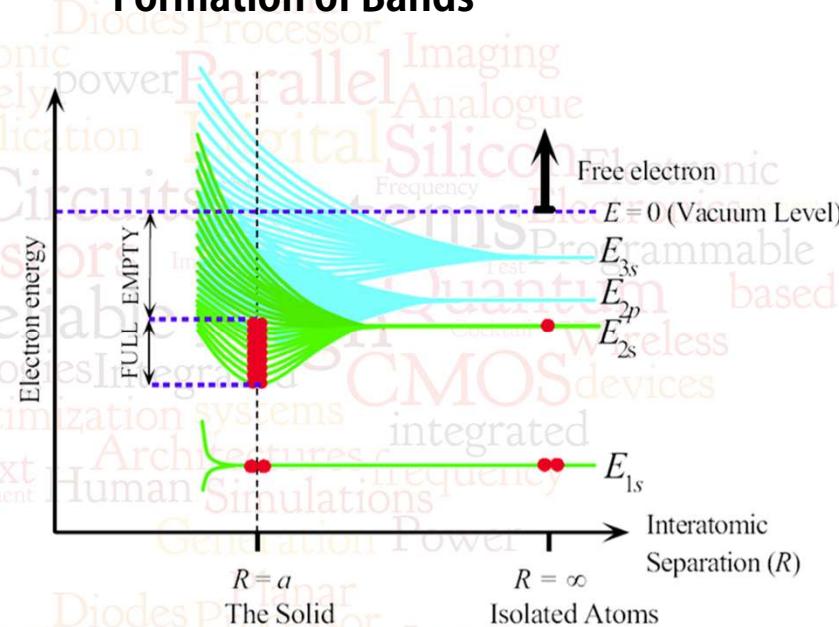


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Formation of Bands

As Li atoms are brought together from infinity, the atomic orbitals overlap and give rise to bands.

Outer orbitals overlap first. The 3s orbitals give rise to the 3s band, 2p orbitals to the 2p band, and so on. The various bands overlap to produce a single band in which the energy is nearly continuous.



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Band Theory of Solids

In our analysis through all of the earlier lectures, we do not have a solid to begin with. Instead the atoms are independent to begin with and are brought together to build the solid. All of the electrons are bound to their respective individual atoms to begin with. In this case the atoms are free to begin with while the "**electrons are tightly bound**" to begin with. In view of the focus on the electronic properties of the materials, this approach is referred to as the **Tight binding approximation** – highlighting the status of the electrons at the start of the model.

There is another approach to modeling materials which starts from a diametrically opposite position. In this approach, we adopt a picture of the solid that says that there are ionic cores at fixed lattice locations and that there is a free electron gas enveloping these ionic cores. In other words we assume that the solid already exists and that the ionic cores are tightly bound to their lattice locations while the "**electrons are free**" to run through the extent of the solid. This is called the **Free electron approximation**.

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