The Physics of Solar Power

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Introduction

How do Photovoltaics work?
Photovoltaic panels, more commonly known as solar panels, are usually made of semiconductor materials. The most common semiconductor material used in solar panels is Silicon. To explain how a solar panel creates electricity from sunlight, we first have to understand how **Semiconductors** conduct electricity.

Semiconductors

For a semiconductor to function as a photovoltaic cell, we need to **Dope** the semiconductor material.

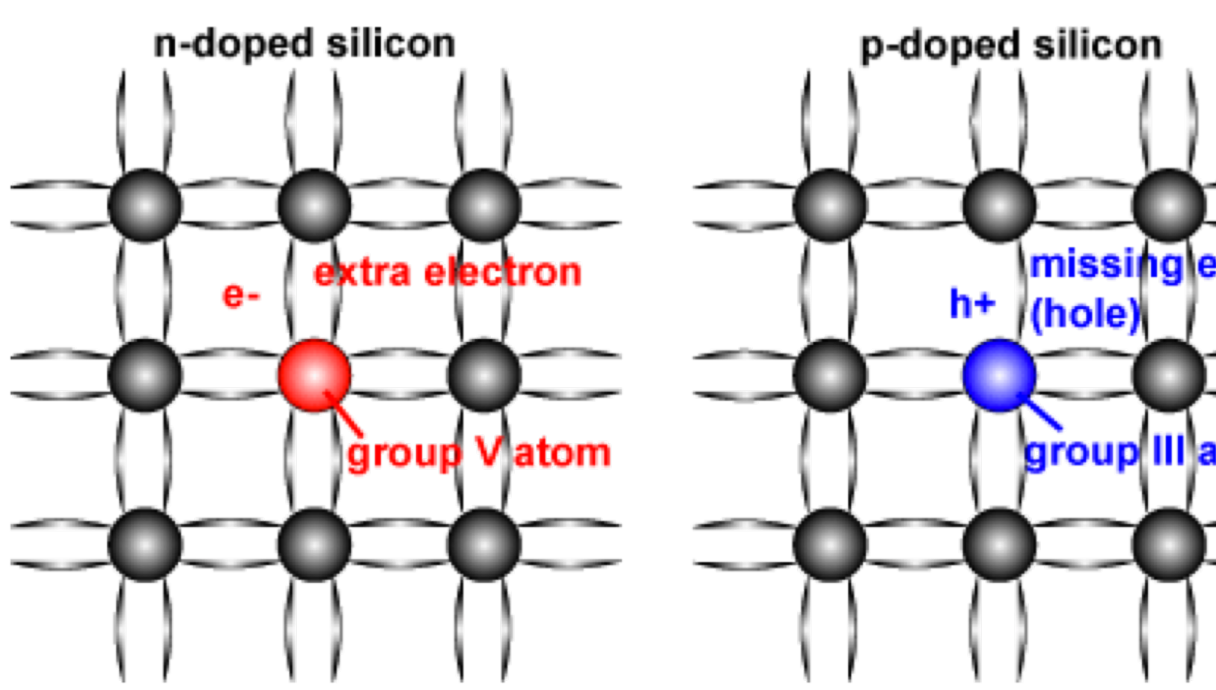


Image 1

Semiconductors can be doped in two ways:
N-doped, where elements with more electrons are added to create a negatively charged material
P-doped, where elements with fewer electrons are added to create a more positively charged material

With the two doped regions, we can create the **PN-Junction,** which is essentially the entire structure of a solar cell

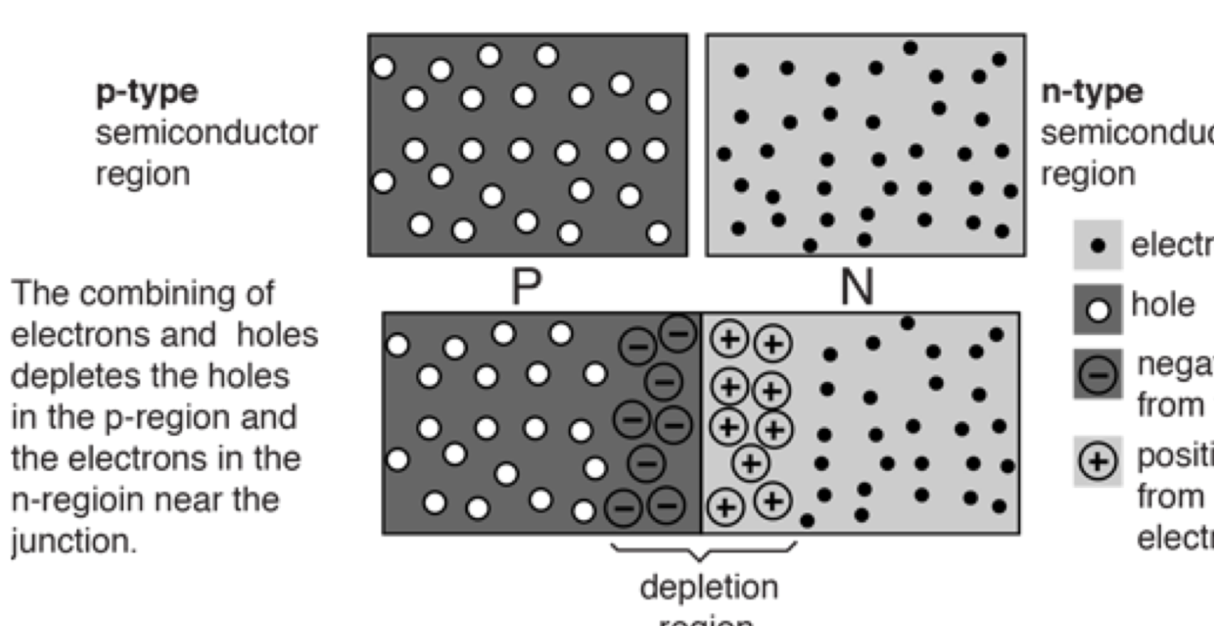
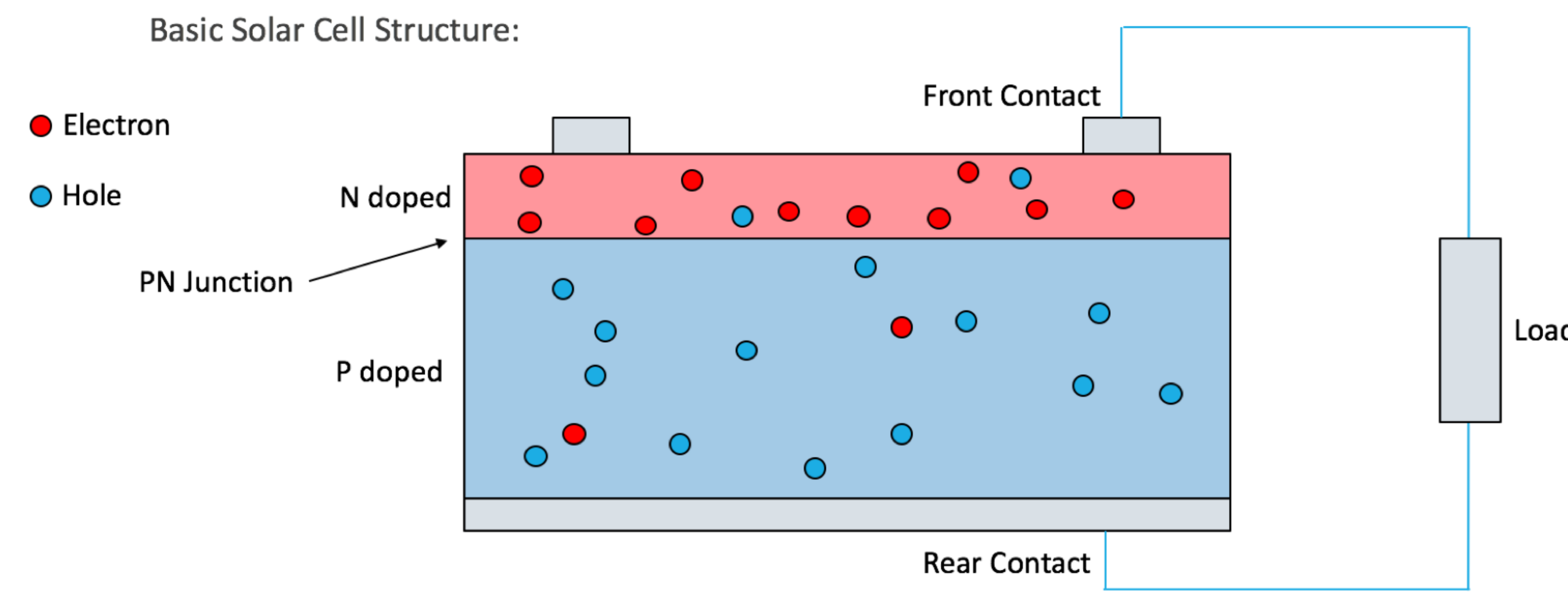


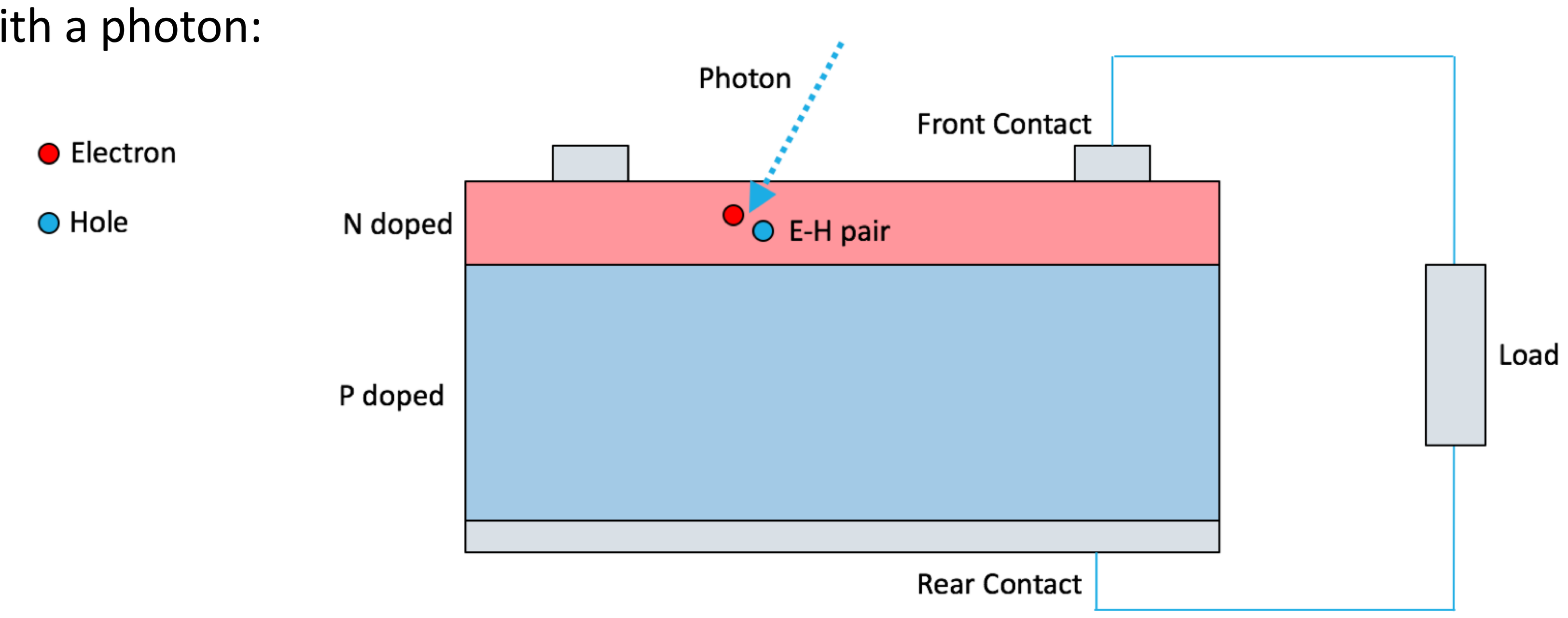
Image 2

The PN-Junction allows for electrons to flow under only certain conditions. For a solar cell to work those conditions need to be met. In the next section to the right, the structure and function of the solar cell will be explained.

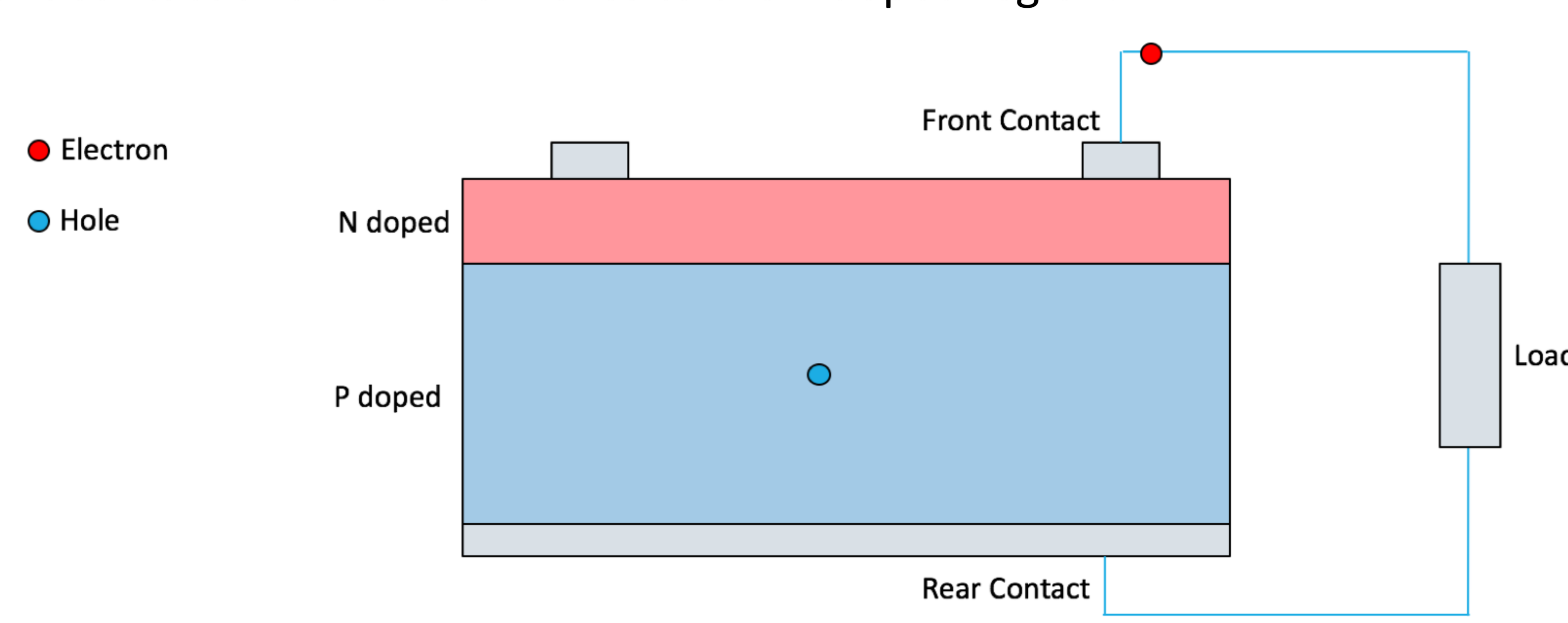
Solar Cell Structure and Function



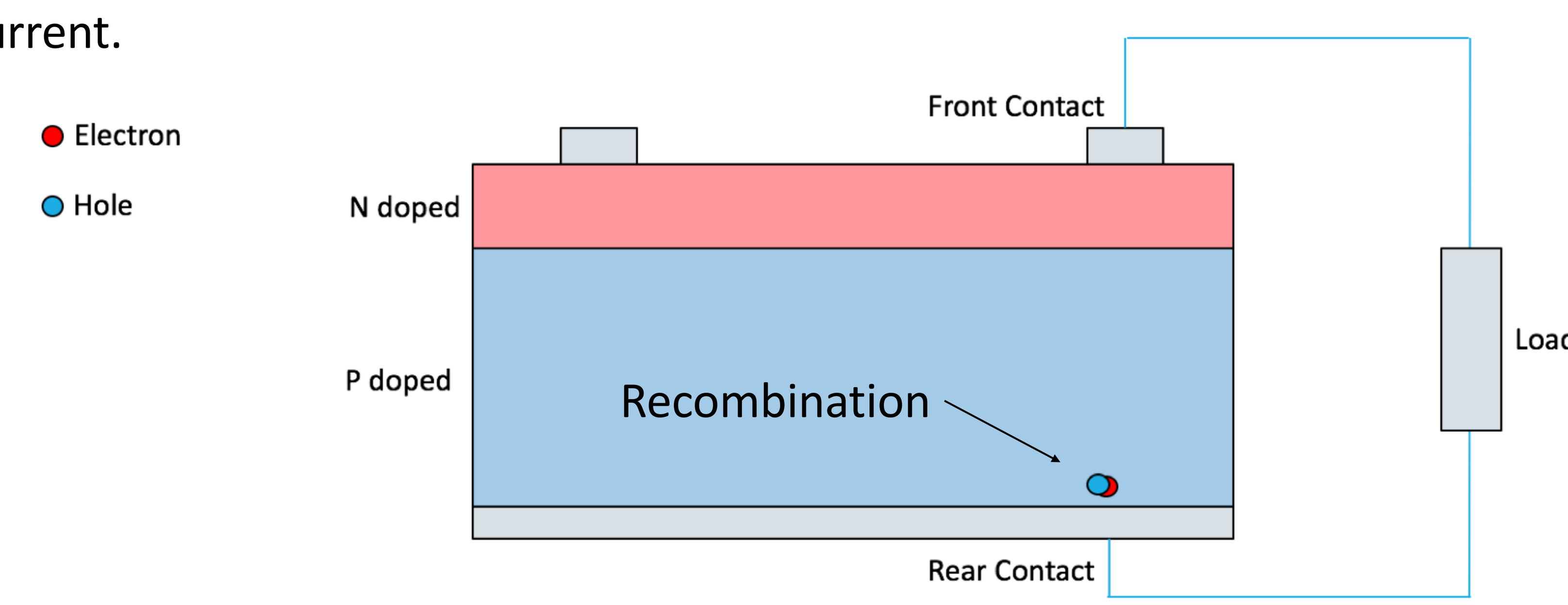
A solar cell is essentially one large PN-Junction, with the N-Doped region on top and the P-Doped region below. To create electricity, the solar cell needs to be hit with a photon:



An electron absorbs the photon, which excites it, moving it to the conduction band and creating an electron-hole pair. The electron then moves through the front contact and the hole moves to the P doped region:

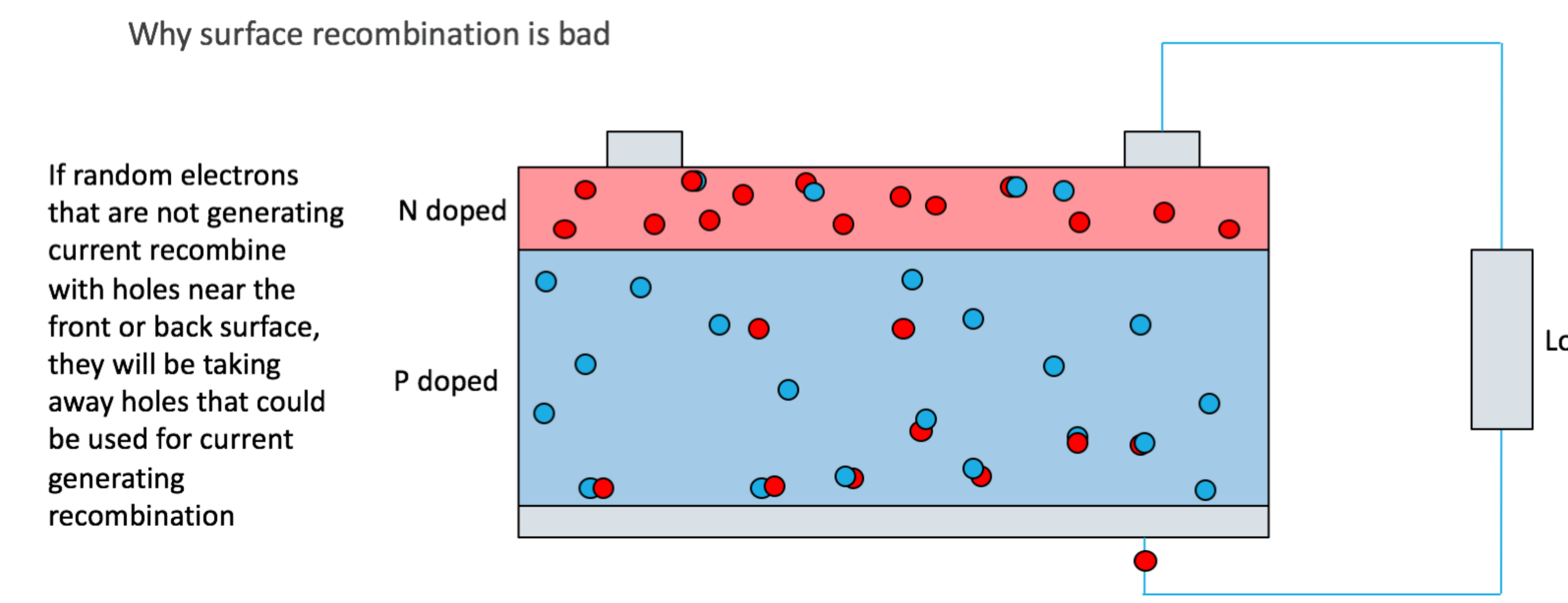


The electron and hole eventually recombine near the rear contact. This process happens continuously while photons are hitting the surface of the cell, thus creating a steady stream of electrons through the wire, resulting in an electrical current.



Surface Recombination:

Surface Recombination is a recombination between an electron and a hole that takes place near the front or back surface of the cell, between non-current generating electrons and holes. This is **BAD** for efficiency. Ideally, you only want the electrons and holes created by photons that actually go through the circuit and generate current to recombine. That way, you can optimize efficiency.



Defeating Rear Surface Recombination

To prevent rear surface recombination in a solar cell, we can create a more heavily P-Doped region near the back edge of the cell to remove latent electrons in the structure. This more heavily P-Doped region, or P+ region, is called the **Back Surface Field**, or BSF.

Maximizing this BSF around your rear contact means that your current generating electrons coming through the circuit will have an easier time recombining, thus creating a more efficient cell.

Acknowledgments

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Image References:
Image #1: Public Domain
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