[MUSIC PLAYING]

PROFESSOR: Hello, everyone. In our last demo, we demonstrated how the electrical conductivity of silicon can be changed by over six orders of magnitude by adding dopants that can increase the number of free or mobile charges in the material. Today, we'll show how we can use light to break electronic bonds and silicon, and create free mobile charges. The principles we'll be using today can be applied to everything from sun screen, to of course, solar cells. We'll use the undoped, or intrinsic silicon sample from our last demo, and measure how the conductivity changes when we shine light on it.

Our set up is identical to that of last time. We'll take a piece of silicon with metal contacts. We'll use an ohmmeter that we connect to our sample via metal wires to measure its conductivity. The measured resistance will be determined by the conductivity and the size and shape of our sample. Finally, we represent the connectivity in terms of our measured values and relate it to the number of free, mobile charges, and the material properties of silicon. We'll first measure the conductivity of our sample in the dark, and then shine light on our sample and see how the conductivity changes.

Our ohmmeter is hooked up to our sample, and we measure a resistance of around 120,000 ohms, which is equivalent to a conductivity of around 0.0002 inverse ohm centimeters. Now, let's flip on the light. We can see that we measure a slightly lower resistance of around 40,000 ohms, but what is light doing to affect the conductivity so much. Let's zoom in to the atomic level and explore why.

We see here a 2D representation of a pure silicon crystal where all the valence electrons form rigid covalent bonds, are immobile, and don't allow the flow of electricity. This material structure is identical to our intrinsic sample when in the dark, which has a very low conductivity. When light hits our sample, photons of sufficient energy can break these covalent bonds, injecting the formally immobile electron, giving enough energy to move around.

The mobile electron leaves behind a mobile hole, which can move through the crystal by swapping positions with neighboring covalently bonded electrons. This explains why the light increases the conductivity of our sample. Again, our conductivity is determined primarily by the number of mobile charges. Light creates additional pairs of mobile electrons, and holes, thus increasing n and our conductivity.

We've demonstrated that light is able to generate fee carriers in our ultra-pure sample. The same effect still happens in dope silicon, but the light induced change in conductivity only creates a small relative change that we can't measure using our ohm meter. Generating these extra mobile charges by breaking covalent bonds with light is the source of the electricity that we eventually collect in our solar cell.

In the next video, we'll explain how these light generated mobile charges will be collected and converted into electricity. I'm Joe Sullivan, thanks for watching.

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