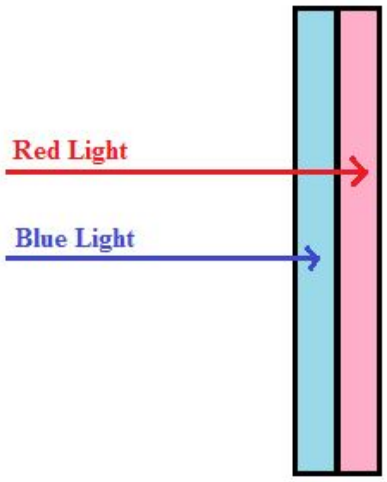
Investigation of Esaki diodes for more efficient solar cells

The high energy consumption in the modern world necessitate an efficient and renewable power source such as solar cells to convert the energy from the sun to electricity. To make the solar cells more efficient, multiple cells can be connected in a series. As it is a good connection between the cells, Esaki diodes have been simulated in this thesis.

There is a growing problem in the world today with depleting oil resources and increasing greenhouse effect. Nuclear power can be an alternative but it is also a finite resource. Therefore the only sustainable energy sources take their energy from the sun. The global energy consumption is about 200 000 TWh yearly but the sun provides the earth with 10 000 times as much energy and is therefore a good candidate for supplying us with the energy we need. Solar cells are the natural option since they absorb the energy from solar rays and turn them directly into electric current.

When light hits the solar cell the electrons take energy from the light and can begin to move and therefore generate an electric current (which is electrons traveling). Some energy from the photons also becomes heat.



We all know that some materials are transparent and some are opaque, the reason for this is that materials have a different limit for how low energy they can absorb, some can absorb visible light and others cannot. For example glass is transparent to visible light but can absorb UV-light, since UV-light has a higher energy than visible light.

Unfortunately it is not optimal to use a material that absorbs as much light as possible, since much of the absorbed energy becomes heat. Therefore the optimal would be to have a material on the top that absorbs the light partially and is transparent to the rest (blue material in the figure) and on the bottom a material that absorbs most of the rest of the light. The more of these layers the better efficiency the solar cell will have.

The focus of this master thesis has been on the connection between the layers, which is called an Esaki diode, after Leo Esaki. I was doing computer simulations to test an approximation to see how far the it is valid and how accurate it is for Esaki diodes and to model how it might change with different parameters.

The result was that it was not very accurate and that certain changes in the simulations are needed for more accurate result. Although not a very exciting result it is work that needs to be done so others know they need to invest time in better simulations without wasting time with simpler one. Sometimes simple simulations with low accuracy are needed and sometimes more complex simulations with higher accuracy are needed.