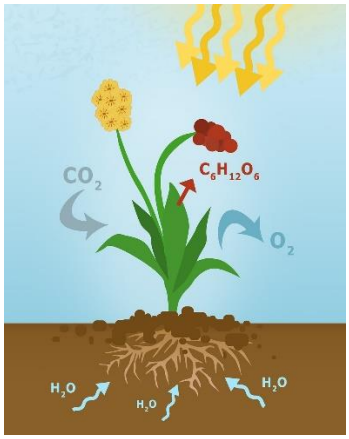
Iron-Based Solar Cells of Tomorrow?

Solar energy is a renewable energy source harvested by solar cells. But even if there are functioning solar cells on the market, the hunt for even better ones are engaging many scientists. This project has contributed in the development of a solar cell inspired by nature, that is using simple compounds to form the versatile solar cell of tomorrow: a solar cell that is environmentally friendly, can have different colours and can be made bendable.

Today, climate change is a fact, bringing terrible consequences for humanity if it is not mitigated. To meet the energy demand of the world, we should use renewable energy sources in order not to contribute further to climate change. There are already renewable energy harvesting techniques on the market such as wind turbines, water power and solar cells. But why not look at how mother nature has solved the problem?

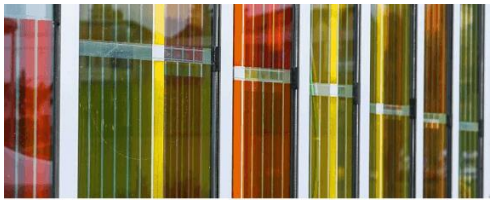
Almost all energy accessible on earth comes from solar radiation, i.e. light from the sun. Mother nature harvests the light by using dye molecules such as chlorophyll present in plants and some bacteria. When the dye molecule harvests the light, an electron is separated and used to form an energetic molecule that can be used to build up the plant. This process is called the photosynthesis.



The principle of photosynthesis: the plant uses sun light, carbon dioxide (CO_2) and water (H_2O) to fabricate the energetic molecule glucose ($C_6H_{12}O_6$) and the by-product oxygen (O_2). Image from Pixabay.

In a dye-sensitized solar cell, scientists want to mimic the photosynthesis by using dye molecules to harvest the light from the sun. Instead of creating energetic molecules, the electrons are extracted as current. The dye molecules are synthetically made and are similar to chlorophyll in the sense that they often consist of a metal ion with organic ligands attached to it.

Scientists at Lund University have had a breakthrough within the dye-sensitized solar cell field since they have managed to use dyes with iron as the metal ion. Iron-based dyes are desirable to use since iron is very abundant, non-toxic and environmentally friendly. An iron-based dye-sensitized solar cell could in the future be an eco-friendly, versatile and easy to fabricate option to other types of solar cells.

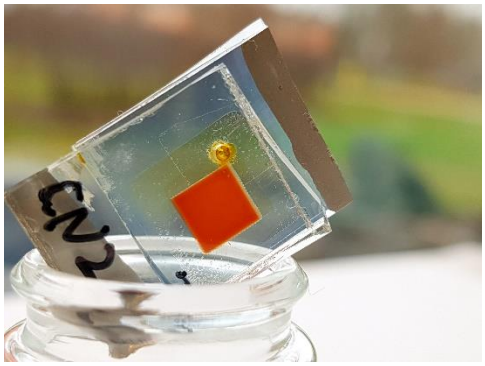


Examples of dye-sensitized solar cells. Image from Blogionic.

At Lund University, different iron-based dye molecules are synthesized and investigated to assess their potential usage in solar cells. Since each dye molecule is unique, they have for example different colours. This means that solar cells with different dye molecules can catch a greater part of the solar light spectrum and at the same time create colourful surfaces on e.g. buildings. The solar cells can also be made bendable, to be able to cover a wide range of new surfaces not covered by common solar cells today.

In this project, two new iron-based dye molecules synthesized at Lund University were investigated. From calculations and spectroscopy measurements both dye molecules seemed promising. In a collaboration with Uppsala University, the dye molecules were used to

fabricate solar cells that were then investigated. And for one of the dye molecules the solar cells did work!



A dye-sensitized solar cell fabricated in this project.

One of the dye molecules yielded solar cells with a top efficiency of 0.13 %. This might not seem like much, but it is actually in the range of what the most successful scientists within this field have achieved with iron-based dyes! Also, the fabrication process was not optimized, meaning that a higher efficiency most probably can be achieved after optimization.

The goal is to make iron-based dyes performing among the best dyes in the solar cell field. By investigating the potential and properties of the two new dye molecules within this project, a deeper understanding of iron-based dyes has been established. The characterisation will add to the design and development of the next generation of iron-based dyes.

Master's thesis "Iron-Based Dye-Sensitized Solar Cells – from Theory to Working Solar Cell" by Linnea Lindh