Popular Science Summary

The acute problem of obtaining clean energy is getting more and more apparent each day. The need for energy-efficient renewable systems is growing but is limited by physical processes that govern the energy generation from renewable sources. A prime example is solar, which some parts of the world are having in abundance, while the solar energy capture and conversion into electricity, using solar cells, is a very inefficient process. The aim of this work would be to enable the optimization of the solar cell to be better receptive towards harvesting solar energy.

The solar cells are typically made from a single material that absorbs light, that being silicon. It is an abundant material, found mainly as sand. It absorbs light fairly well, but it has a limit in how efficient it can be in absorbing light. Therefore, an idea can be to add different layers that would help in absorbing light and increase efficiency. The more absorbed light in a cell, the better its efficiency is, and higher energies can be achieved at the output of a cell. It would result in more energy being available for consumption, which then reduces the number of cells which need to be installed. Such solution would lower the electricity costs, so the society would benefit from it in the end.

One important aspect of developing such materials that enhance solar sell efficiency is understanding the properties of materials and finding the optimum material that can be used. Out of many methods, this work uses a method where high-energy light is shined onto a material and the light that is returned from the material is then examined. This is typically done in big facilities which are known as synchrotrons. They can be of great help to understand the properties of the specific material, as well as differentiate how many of specific elements there is in the material. Typically, a combination of several elements would enable the improvement in the energy efficiency of the solar cell. Such compound materials are called perovskites, because of their specific properties, and materials that are used to create a compound.

This work attempts at understanding basic material properties by analyzing synchrotron imaging of perovskites, which are intended to be implemented in high-energy-efficiency solar cells. The data is stored in multidimensional arrays, so it is useful to develop an algorithm that would efficiently process and interpret this measurement data, providing relevant information and understanding what materials are present in the perovskite, as well as to what amount. Material proportions are important, in order to build a high-efficiency solar cells. Analyzing the measurement data in an algorithm also makes the process of understanding the material easier and faster, which reduces the material development time. Combining different methods may result in a desired material that can be implemented, for the benefit of all.