

Infusing photoconductivity by nanocrystals functionalization; or how a sauce of quantum mechanics can shape light detection.

The capacity of detecting light has been long pursued by both mother nature and humankind technological progress. The complex biological eye, the video cameras in our smartphones or the X-ray diagnosis tools in hospitals are different light sensors that one way or another impact our lives. However, traditional sensing methods have encountered a common limitation: distinguishing light with very similar color. So how is currently science pushing the limits of light detection?

Small differences in color distinguish dry, wet and icy road. Being able to discern between them could lead to dramatic improvements in road safety, but these differences are not perceptible by human eye. Existing technology is currently able to distinguish between these colors, but achieving that challenge requires complex and expensive equipment. In order to provide for a detection system accessible to most, science is developing new light detection methods that rely on different quantum mechanical effects. In particular, this project investigated light sensing using a mindblowing effect known as «quantum confinement».

The quantum confinement consists in redefining with high precision what can exist inside a certain structure and what cannot. When applied to light sensors, the quantum confinement effect does exactly the job we need: it allows the existence of some colors in the detector and removes all the rest, regardless of how similar they might be.

However, there is a catch. As many other quantum mechanical effects, the quantum confinement only shows in nanostructures; objects so small that might be made of only few thousands of atoms. Such structures are often very difficult and expensive to produce, and implementing them in industrial production represents a challenge in many cases. The goal of this thesis is precisely to study simple enough methods to create the desired sensors at low price and with easy mass production implementation.

Using different materials and experimental techniques, we studied different possible methods to create the desired light sensors. Our results show that the production of nanocrystals, a particular type of nanostructure, in the structure of the sensor could be the key to embody the quantum confinement. The use of nanocrystals is thought to be suitable for the achievement of our goals because they can be produced using materials and methods that are already well implemented in industry.

Our conclusions are expected to contribute not only to the production of better light detectors, but also to reach a better understanding of how to manipulate the nanostructures.