

Safe(r) quantum dots



WHAT ARE QUANTUM DOTS (QDs)?

They are small **semiconductor nanoparticles**, less than 10 nanometers, which emit light. According to their size and composition, they emit different light color, for instance:



orange color





□ In TV screens, the presence of quantum dots **improves the color** quality of screens.

As targeted tools in biomedical diagnosis.



ATTRACTIVE BUT POTENTIALLY TOXIC

Nowadays, QDs used are composed by a **cadmium based** (Cd) core.



These cadmium based quantum dots may be **toxic** during use, if they are released.



OBJECTIVES

Developing new, **safe(r) by design** formulations of QDs which should have the **same optical properties** as the Cd-based ones.

Two combined strategies have been experimented:

- **G** for the QD core, replace cadmium (Cd) by an alternative chemical element : Indium (In),
- avoid the release of potential toxic ions by enhancing the protection provided by optimal shell(s).



EVALUATE THE TOXICITY

The toxicity has been characterized on **human** keratinocytes.

They are the **major composants of the epidermis**, they multiply near the basal layer, then differentiate and migrate to the surface of the skin.



The **toxicity of QDs** is characterized through:

• CYTOTOXICITY Cell viability

GENOTOXICITY
DNA alteration

OXIDATIVE STRESS
Damage to the cell redox balance

SOME RESULTS OF THE PROJECT

Different QDs were developed using phosphated indium (InP) core, the toxicity of these QDs has been examined through several tests:



The **core** of the QDs degrades rapidly and remains very toxic after aging.

The addition of the **shell slows down** the **degradation** but transformated QDs remain **toxic**. Indeed the shell is **too unstable** to protect the core over time.

The double shell provides an **improved and a longer lasting protection** against the released of toxic forms of the QDs.

* QDs were aged in a climatic chamber simulating **environmental conditions** (UV light, humidity and temperature).



Replace cadmium by indium and **enhance the protection provided by the shell** are **two efficient strategies** to limit the toxicity and the exposure to quantum dots.

LIFE CYCLE STAGES STUDIED





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