Cross-Linking of Quantum Dot Polymer Fibres via a Photoinitiator

What is a Quantum dot?

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- Semi-conductor nanocrystals
- Highly customisable
- Fluorescent

Negatives
- Nanotoxicity (causes disease by diffusing through your cells)
- Often made of heavy metals
- Expensive to buy

Quantum dot customisability
- Can be made from all sorts of materials
- Environmental factors (such as temperature and present gasses) can influence colour of QD

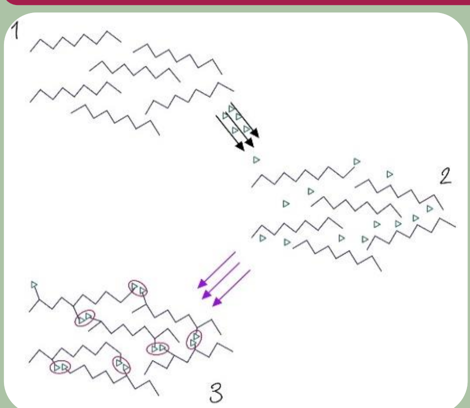
Quantum Dot encoding
With known fluorescence peaks, QDs can replace bar codes in packaging for high value items.

Quantum dots from Avantama.com

Solution? Cross-linking!

Cross-linking
The process of forming bonds between molecules to build strength in a substance.

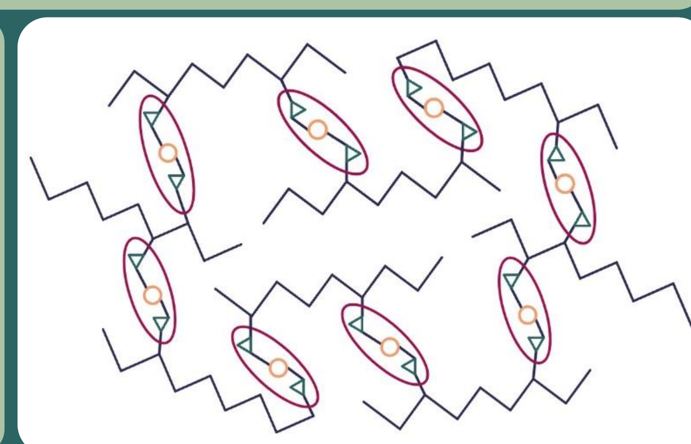
How can we initiate cross linking?
We can introduce a Photoinitiator so that when the solution is hit with UV light, bonds are formed, and cross-linking occurs.



The diagram to the left depicts how we can introduce photoinitiators to create bonds in a polymer. Stage one is simply the polymer on its own in solution. Stage two is the solution once the photoinitiators have been added. Stage three shows when the solution has been exposed to UV light, the photoinitiators generate free radicals which then form bonds between the polymer chains. (The zig zag lines represent the polymer chains, the green triangles represent the photoinitiators, and the lines between them represent the bonds formed.)

Using this technology of cross-linking, we can bond our photoinitiators to the Quantum Dots so that free radicals are formed on both the surface of the QDs, and the polymer chains. This will allow everything to lock together as shown in the image to the right. The QDs are represented by the orange circles.

The main application of this technology that we are interested in is for use I food packaging to make responsive polymers that can indicate when an item of food has past it's best. The benefits of this are that both companies, and the public can save money and the planet by reducing food waste.



What have we done?

We have tested various concentrations of our photoinitiator and polymer in solution under UV exposure of two wavelengths and for various times to investigate how excitation energy and exposure time effect cross-linking.

Through analysing our samples qualitatively, we found that the solution thickened by a noticeable amount. This leads us to believe we have achieved cross-linking. However, more characterisation is required to confirm this.

To analyse the efficacy of the photoinitiators we used RAMAN spectroscopy as well as qualitative analysis, such as a change in colour and/or viscosity.

This project is merely the first of many tests and trials that are required before this technology is fully developed, but it is a promising start. If we can achieve such results as these in 6 weeks, imagine what could be achieved over a full year of funded research. A continuation of this project would include further analysis of the cross-linking through FTIR and a full-scale test with a higher concentration of polymer and the surface bonded QDs.

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