2008 TAIWAN INTERNATIONAL SCIENCE FAIR

CATEGORY : Chemistry

PROJECT : The Beam of Hope

AWARDS : Chemistry Second Award

SCHOOL : Otago Girls' High School

FINALISTS : Marina Kamel

COUNTRY : New Zealand

Category: Chemistry.
Title of Project: The Beam of Hope.
Applicant's Name: Marina Kamel.
Country: New Zealand.

Abstract of Exhibit

As the most dominant species on planet Earth's surface, humans have become the sole protectors of the planet, in charge of keeping it hospitable for billions of species. However, a swift look around Egypt's streets in contemporary 2007 showed proof of our exploitive use of fossil-fuels. Provoked by such a scene, I set out to discover the negatives of fossil-fuel consumption that more than 2 million websites were ready to detail. The increased CO_2 emission, due to fossil-fuel use, is contributing to the greenhouse-effect, causing global-warming and thus leading to climate-change. This affects biodiversity by causing the eventual extinction of species, thus upsetting food-chains and affecting humanity in the long-run. Statistically 40 more years of consumption are left if the current rate-of-consumption persists. My proposal is to use solar-energy as an alternative power-source. Two requirements must be fulfilled: it must hold research potential and shouldn't suffer from problems associated with fossil-fuels. 3rd-generation nanocrystalline dye-sensitised solar-cells have a conductive-glass-electrode coated with titanium-dioxide, then a layer of dye on it for light-absorption, electrolyte and finally a counter-electrode coated with graphite.

In the dye-experiments, dyes extracted from fruits & vegetables, and the wavelengths of visible-light-spectra that they absorb, were examined using a UV-spectrophotometer. The solvent for the extraction-process was tested and ethanol was better than water because it actively extracts the dye while water doesn't help and contains ions that alter the dye's absorption-abilities. I combined 2 dyes: chlorophyll (absorbs the red & violet areas in spectrum) with blackberry (absorbs the green area) thus enabling the solar-cell to absorb the entire spectrum and maximising its power-reading. I investigated whether the dyes should be freshly-mixed or combined earlier (and used every time to build the cell). Freshly-mixing dyes is better because that stops the enzymes that were extracted out with the chlorophyll from denaturing blackberry's anthocyanins and rendering them dysfunctional thus the dyes work better maximising the power. Testing the dye-combination's concentration showed that the 6.25% concentration is the best because it can coat the TiO_2 with a single-layer of dye instead of high concentrations that give multiple layers of dye which doesn't give good electron transition or low ones that don't give enough dye which means a lower amount of electrons are being excited and thus less power. In the material-section, anatase and rutile, TiO_2's 2 major constituents (structurally identical but with different crystal-orientation), were compared and anatase proved itself better because of its smoother conduction-band. Different anatase particle sizes were examined and the smaller particles (4 nm) were better because of increased surface-area. I investigated the ways of coating the counter-electrode and found that using carbon-paste is the best.

Ultimately my solar-cell's power-reading increased from 2.04 nW to 6.41 μW which is 3142 times the initial reading, a dramatic increase for a solar-cell whose size doesn't exceed 4 cm^2. This proved the great research potential held by solar-energy. After extensive comparisons between the ups and downs of both fossil-fuels and solar-energy, solar-energy clearly proved itself the perfect alternative for powering our future.

Word count: 500 words

評語

1) 研究設計完整且有很好的邏輯。

2) 實驗結果的解釋，強而有根據。