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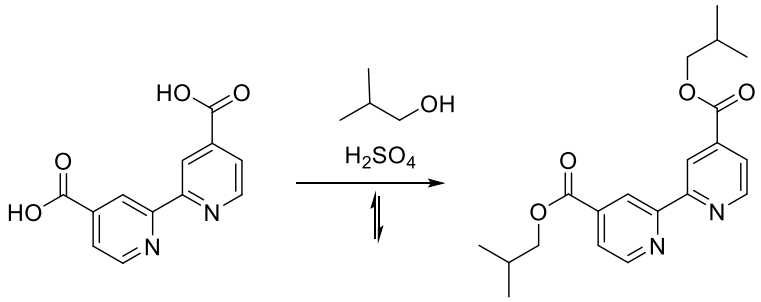
Solar Cell Project Implementation and Setup Notes:

Synthesis of initial Ester Ligand:



Procedure can be found in the Supplemental Information for the provided paper for the N719 synthesis.

The ester ligand was initially reported to be used instead of the carboxylic acid ligand (even though the ester needs to be saponified later in the complex synthesis) to allow for silica gel chromatography of the complex to remove impurities prior to final formation of the ammonium salt. For the purpose of this undergraduate laboratory, the chromatography step is not necessary, as the initial product is pure enough after precipitation to carry forward.

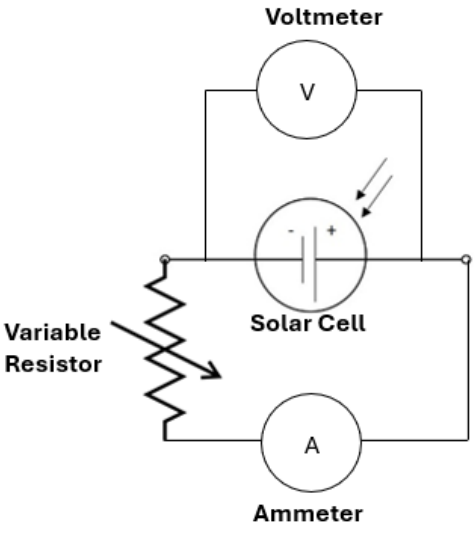
However, using this ester ligand was still found to be valuable, as it allowed for faster reaction times compared to using the acid ligand, and the resulting crude complex is much cleaner when using the ester ligand than the crude product obtained when directly using the acid ligand, based on prior years work by undergraduates in the course.

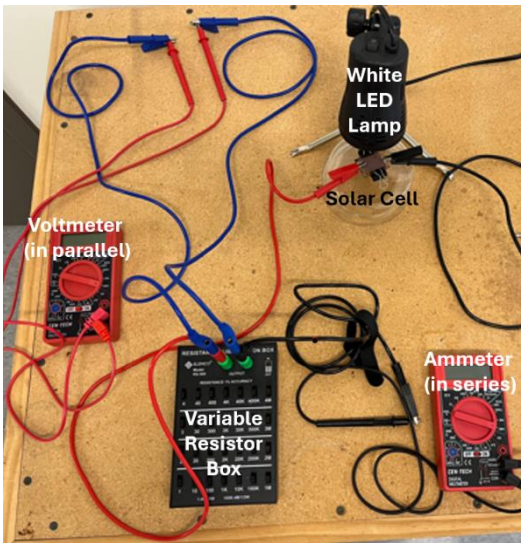
Thus, it is certainly worth the extra step to make and use this ester ligand.

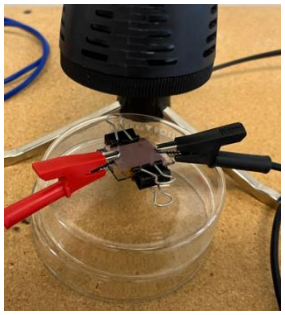
Setup for Generating I-V Curves to Evaluate Solar Cell Performance

The performance of the solar can be investigated by recording a graph of measured current through the circuit versus voltage across the solar cell under a constant light source but at different resistance loads.

The completed solar cell is secured under the light source. A variable resistor box in series in the circuit is used to systematically increase the resistance of the circuit, and data points for both voltage across the cell and current through the circuit are recorded at each resistance.







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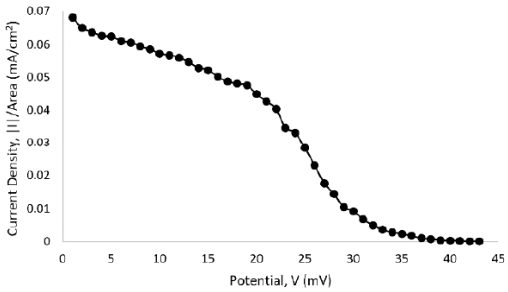
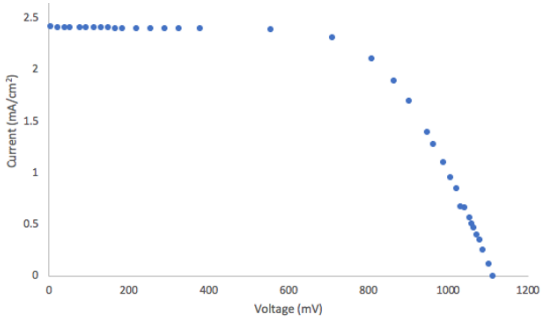
Example Student-Generated I-V Curves



Student-made N719 Dye-Sensitized Solar Cell



Small commercial toy solar cell

Examples of Equipment Used

The following is the equipment currently used for this project. Upgraded equipment is fine, but these products work well enough. A brighter light source would be more desirable than the one presented here that is currently in use for this project.

ITO-doped glass slides: Sigma Aldrich, product number 703192

(https://www.sigmaaldrich.com/US/en/product/aldrich/703192)

Inexpensive Multimeters: Harbor Freight, 7-Function Digital Multimeter

(https://www.harborfreight.com/7-function-digital-multimeter-63759.html?utm_source=google&utm_medium=cpc&utm_campaign=12188110019&campaignid=12188110019&utm_content=151674056851&adsetid=151674056851&product=63759&store=415&gad_source=1&gclid=CjwKCAjwkuqvBhAQEiwA65XxQBX0SJfShfoO-gNHjCznSqP-7sdxxgNR8DH6z0hG3KQ67iW35qRPTBoCPzEQAvD_BwE_

Variable resistor box: Elenco Resistance Substitution Box

(https://www.amazon.com/gp/product/B0002KX76M/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&psc=1)

Wires with alligator clamps: Sumnacon Multimeter Banana Plug to Crocodile Alligator Clip Test Probe

(https://www.amazon.com/gp/product/B071SL6PQS/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&th=1)

White LED lamp: LimoStudio Photography Continuous 5500K LED Portable Light Lamp

(https://www.amazon.com/gp/product/B00RKJ0ZFE/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&th=1)