Fueling the World One Layer at a Time: Improving the Efficiency of the Gratzel Cell with Nanotechnology

Dwyer, Aidan

A Grätzel solar cell (nano-crystalline dye sensitized or “DSSC”) is a photo electrochemical cell that use photons to excite electrons in organic fruit dyes to create electricity. The Grätzel cell uses titanium dioxide (TiO2) as a primary component for power generation. Researchers are investigating the Grätzel for its potential to provide power at low manufacturing costs. DSSC technology, however, faces challenges. Current DSSC design is less efficient than conventional PV cells. While researchers have focused their efforts in developing better organic dyes to increase efficiency, almost no investigation has been conducted into improving the efficiency of other components of a DSSC including the TiO2 substrate and carbon/graphite counter electrode. This research investigates the potential of utilizing a graphene matrix in the counter electrode and using volcanic ash as an alternative to TiO2 in DSSC design. DSSC prototypes were designed and constructed using the proposed modifications and tested and compared with conventional TiO2 Grätzel models. A graphene matrix was substituted for conventional carbon/graphite substrates and four sources of volcanic ash were tested as a substitute for TiO2. Experimentation suggests that both graphene and volcanic ash markedly increased power efficiency. Modified prototypes produced open and closed circuit voltages in the general range of .27- .31 VDC compared to a general range of .15-.20 VDC in the conventional TiO2 DSSC. A final Hybrid Prototype utilizing a mixture of TiO2. Volcanic ash and graphene matrix resulted in significant overall gains in efficiency and output integrity. Further investigation is recommended to assess this novel modification.

Awards Won:

Third Award of $1,000