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## Organic use of chlorophyll extracted from green algae in Dye-Sensitized Solar Cell

This study investigates the extraction methods of chlorophyll extracted from green algae to be used as a natural photosensitizer in dye-sensitized solar cells (DSSCs). Three extraction methods were employed: solvent-assisted extraction (SAE), ultrasonic-assisted extraction (UAE), and microwave-assisted extraction (MAE). Chlorophyll was then characterized for its optical, morphological, and structural properties. Ultraviolet-visible (UV-vis) spectroscopy revealed absorption peaks which correspond with chlorophyll a, chlorophyll b, carotenoids and flavonoids. The MAE method produced the highest chlorophyll yield. Furthermore, direct band gap of the extracted chlorophyll was estimated using Tauc's plot analysis which revealed 1.67 eV and 2.5 eV suggesting efficient light absorption. Photoluminescence (PL) showed a higher intensity in MAE and UAE as compared to SAE. Confocal microscopy images further confirmed the presence of chlorophyll a (green) and chlorophyll b (red), providing visual insight into the distribution of pigments within the algae. Scanning electron microscopy (SEM) morphology revealed line-array surface structured with longitudinal orientation. Fourier transform infrared (FTIR) spectroscopy identified structural and functional groups with prominent peaks around 878 cm<sup>-1</sup>, 1045 cm<sup>-1</sup>, 1639 cm<sup>-1</sup>, and 3341 cm<sup>-1</sup>, correlating with C-H, C-O, C=C and N-H stretches, respectively. Consequently, the results suggest that MAE and UAE techniques are the most efficient for DSSC application.

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**Primary authors:** MTHIMUNYE, Lindiwe (Department of Physics, University of Pretoria); Prof. DIALE, Mmantsae (Department of Physics, University of Pretoria)

**Co-author:** Prof. MOLELEKI, Lucy (Department of Biochemistry, Genetics, and Microbiology, University of Pretoria)

**Presenter:** MTHIMUNYE, Lindiwe (Department of Physics, University of Pretoria)

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