Femtosecond pump probe spectroscopy of light harvesting complexes and phthalocyanines

Saturnin Ombinda-Lemboumba, CSIR • Supervisors: Dr Anton du Plessis, CSIR • Dr Christine Steenkamp, Prof Erich Rohwer, SU

Background

Nanodevices based on biological materials can degrade into harmless substances and be absorbed into an organism's own structure. Energy transfer in light harvesting complexes (LHCs) is of major interest in femtosecond spectroscopy and will remain so for several years until the energy transfer processes are fully understood, and systems can be synthesised to mimic energy transfer in photosynthetic systems so that the energy transfer can be controlled and manipulated. Commercial relevance is found in highly efficient biological solar cells, among others.

On the other hand, the processes of light absorption and energy transfer are also central to Photodynamic Therapy (PDT). Phthalocyanines are a new class of photosensitisers used for PDT. These drugs are used to treat small and superficial tumours. Particular attention has been given to zinc phthalocyanine (ZnPc) in order to find suitable photosensitisers that can be clinically used as photodynamic cancer drugs. However there are ultrafast processes in ZnPc that are used for the destruction of the cancer.

Response

Research on the fundamental processes that are involved in chemical reaction mechanisms is of critical importance for understanding chemical and biological phenomena. The aim of this study was to investigate energy transfer in synthesised artificial functional light harvesting complexes, by studying energy transfer in natural light harvesting complex II (LHC II), as well as ultrafast processes in zinc phthalocyanine (ZnPc) systems.

Most of the work was done at the femtosecond laboratory at CSIR National Laser Centre. However, experiments on ZnPc in a DMF solvent were carried out at the femtosecond laboratory Laser Research Institute at Stellenbosch University.

Progress

The research has permitted the establishment of time constants of energy transfer from chlorophyll b to chlorophyll a, as well as the energy equilibrium from chlorophyll a to chlorophyll a in light harvesting complex II. The time constants obtained correspond to the values given in the literature.

On the other hand, the study done on ZnPc indicated that there are three time constants involved in energy transfer: two time constants of a few picoseconds which are associated with solvent relaxation and vibrational relaxation; and a new longer time constant (in the order of 40 ps) discovered, is related to the dielectric solvent dynamic relaxation of the excited state of ZnPc. The research complements the work presented in literature which lack data in picosecond time scale.

Outputs

Peer-reviewed journal article – 1
Conference paper – 1