Developing New Photosensitizers based on Transition Metal Ions for Green Energy Applications

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Rising global population and increased CO_2 levels in the atmosphere have focused attention on developing alternative and widely available carbon-free energy sources.[1,2] Our research focuses on harnessing the unique properties of excited states in metal complexes to drive self-assembly processes and develop innovative energy applications. By leveraging the photophysical and photochemical behaviors of these complexes, we explore how light-induced excitations can be utilized to control molecular organization and energy transfer at the nanoscale. The parallels with Natural Photosynthesis are evident: light energy is captured by self-assembled Light Harvesting Complexes and is channeled to a reaction centre which induces electron transfer and the eventual production of chemical energy.[3]

Our approach involves the synthesis of polypyridyl-based metal complexes, which are known for their stability and tunable electronic properties. By manipulating the excited states of these complexes, we demonstrate how light can act as a stimulus to induce self-assembly (Figure 1), leading to the formation of well-defined nanostructures with potential applications in catalysis, sensing, and optoelectronics.[4] Additionally, we extend our approach to the development of photoactive molecular devices capable of storing and transferring electrons, offering insights into the design of next-generation photosensitizers for chemical energy production.[5] We have also moved from second- and third-row transition metal ions to the first row, and explore energy applications of these abundant, inexpensive and relatively non-toxic metal ions.[6]

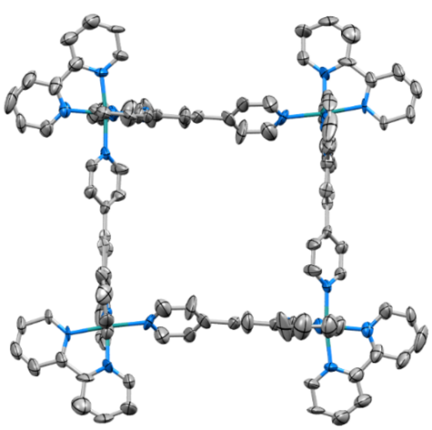

Figure 1. X-Ray crystal structure of a tetraruthenium square assembled by light irradiation. Solvent, hydrogen atoms, and anions are removed for clarity.[4]

References

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Garry Hanan is professor in the Department of Chemistry at the Université de Montréal, where he leads the Green Energy Group and is a member of the Centre for Green Chemistry and Catalysis. He earned his B. Sc. from the University of Winnipeg, Canada, his PhD from Université Louis Pasteur in Strasbourg, France, under the supervision of Jean-Marie Lehn and subsequently conducted postdoctoral studies in Germany with Manfred T. Reetz and in Italy with Vincenzo Balzani and Sebastiano Campagna. Professor Hanan's research focuses on the design and synthesis of supramolecular photocatalysts capable of harvesting solar energy to drive chemical transformations, most notably the photoproduction of fuels via water-splitting (producing H_2) and CO_2 reduction.

He has received numerous distinctions, including awards from IUPAC and NSERC, highlighting his contributions to sustainable chemistry and molecular materials science. He also actively promotes international student exchange.