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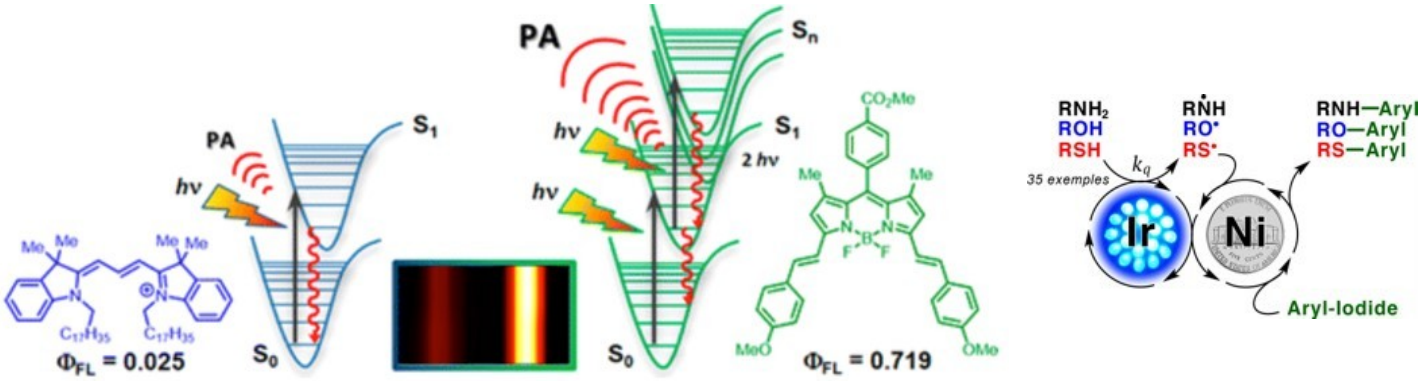
Photons for Imaging and Photons for Production: Examples in Non-Linear Photoacoustic Imaging and Dual-Metal Photoredox Catalysis

Light-driven processes and excited-state chemistry are broadly applied to address difficult problems in chemistry. In this presentation, Prof. Frenette will describe the use of visible light in two emerging fields of research: photoacoustic imaging and photoredox catalysis.Photoacoustic imaging promises to improve cancer detection by generating higher contrast imaging versus traditional ultrasound imaging. This novel imaging technique exploits the conversion of laser pulses into ultrasound and so, photoacoustic contrast agents are molecules designed to absorb light and emit sound. With researchers at UMass Boston, we designed photoacoustic contrast agents that efficiently convert laser pulses into ultrasound by taking advantage of non-linear absorption effects; basically, these molecules can increase their absorption coefficient within a nanosecond laser pulse (J Am Chem Soc, 136, 15853). We demonstrate that non-linear effects can dramatically increase (or decrease) the contrast of this promising imaging technique.



In addition to their application for probing or imaging, photons are increasingly used as tools for organic synthesis. Prof. Frenette and collaborators at AstraZeneca recently reported the use of dual-metal photoredox catalysis for cross-coupling reactions that resulted in carbon-sulfur and carbon-nitrogen bond formation (J Am Chem Soc, 138, 1760; Angew Chem Int Ed, 55, 13350). In these reactions, long-lived and strongly oxidizing iridium excited-states activate nickel-catalyzed cross-coupling between aryl iodides and thiols or amines. Mechanistic evidence will be presented to consolidate two competing mechanisms proposed by our group and those proposed by Prof. David MacMillan (Nature 524, 330; Science, 353, 279).

Mathieu Frenette received his Ph.D. degree in 2009 for research in photochemistry and free radical chemistry with J.C. (Tito) Scaiano at the University of Ottawa. He then pursued an NSERC PDF at Stanford in bioinorganic spectroscopy with Edward Solomon. After two short post-doctoral appointments at McGill and at the University of Massachusetts in Boston, he joined the Department of Chemistry at the Université du Québec à Montréal in August 2015. His research focuses on applied spectroscopy for the analytical chemistry of reactive species and for the elucidation of reaction mechanisms.