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Biography



Kasper Moth-Poulsen is a professor and research leader in applied chemistry, currently affiliated with the Catalan Institute for Advanced Studies (ICREA), the Polytechnic University of Catalunya (UPC), the Institute of Materials Science of Barcelona (ICMAB-CSIC), and Chalmers University of Technology, Sweden. He holds a Ph.D. in organic chemistry from the University of Copenhagen and has conducted postdoctoral research at U.C. Berkeley and the University of Copenhagen. KMP leads a research team of ~ 15 PhD students and postdocs, focusing on advanced materials chemistry, molecular photoswitches, circular materials and laboratory automation. He serves as associate editor for *Journal of Materials Chemistry C* and *Materials Advances*, and is a board member at the Technical University of Denmark (DTU). He is a recipient of several prestigious grants and awards, including ERC Starting and Consolidator Grants, the Göran Gustafsson Prize (2021), the Norblad-Ekstrand Medal (2021), and the Arnbjergska Prize (2019). He is a fellow of both the Royal Society of Chemistry and the Royal Swedish Academy of Engineering Sciences. His research has led to multiple spin-out companies, including Con-Science AB, Solartes AB, AutoSyn AB, and NanoScientifica Scandinavica AB.



Dr. Karine Loubière has received her PhD diploma in chemical engineering from INSA Toulouse in 2002; her thesis was awarded by the French Society of Chemical Engineering (SFGP) in 2003. After several post-doctoral positions, she has entered the laboratory GEPEA (Saint-Nazaire) in 2005 as CNRS research scientist to work on design and modelling of advanced photoreactors for microalgal cultures. In 2009, she has joined the department “Science and Technology for Process Intensification” of the laboratory LGC (Toulouse). Her present research mainly focuses on flow photochemistry, but also on mass transfer across fluidic interfaces (in particular in confined geometries such as Taylor flows or thin-gap cells) and on dimensional analysis. She develops modeling tools combined with experiments in LED-driven specifically-designed microreactors for (i) understanding the coupling between radiative transfer and photochemical kinetics, (ii) acquiring kinetic data of photochemical reactions, (iii) establishing guidelines to optimize the operating conditions and for process scale-up at industrial scale. Recent applications include flow actinometry, photooxygenations with singlet oxygen and photosensitizer-grafted polymer colloids, imine photochemistry in the harsh UV-C, storage energy with MOST molecules or advanced methods for radiative transfer modeling using Monte-Carlo methods. In 2018, she organized the multidisciplinary CNRS summer school on photochemistry and photochemical reactor engineering (<https://photochem.sciencesconf.org>). From 2012 to 2021, she has been an elected member and scientific secretary of the National Committee for Scientific Research of the CNRS (section 12). She is currently co-responsible of the axis “Microreactor & Microfluidics” of the CNRS federation FERMaT, and member of the board of the sub-division “Photochemistry, Photobiology and Photosciences” SP2P for the French Chemical Society (SCF).

Solar Energy Conversion and Energy Storage Materials

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Since the beginning of civilization, humanity has built houses to sustain comfortable living conditions throughout the seasons. In our modern society, about 50% of the total energy consumption is used for heating and cooling. Growing demands for thermal management in many different sectors, from electronics to housing, inevitably mean increased energy consumption. The primary source of heat is coming from the combustion of fossil, bio or waste-based feedstocks, all contributing to carbon emissions.

In this lecture I will present how we are working on developing molecular materials that capture, store, and release both solar and ambient heat without creating any emissions. These molecular solar thermal systems (MOST) are based on molecular photoswitches that absorb light and convert it into stored chemical energy, that can be released on demand^[1-6] (Fig.1). The MOST energy system operates through different principles than traditional solar thermal and can be introduced into compact energy capture and release devices. Recently, the first example of integration of the energy storage system with photovoltaics, and in electric power generation devices was published.^[7] Additionally, I will introduce materials concepts for photon upconversion (TTA-UC) and associated accelerated discovery devices.^[8]

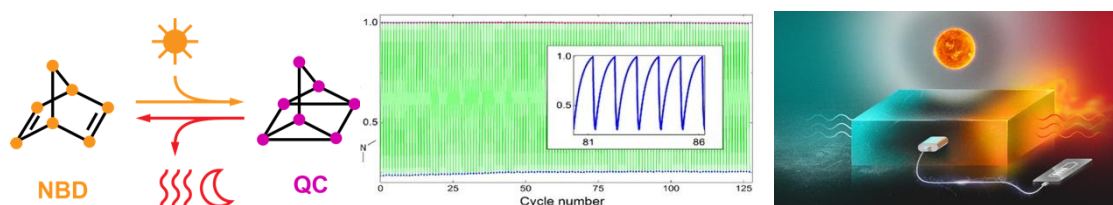


Figure 1. (Left) Molecular structure of on NBD/QC photoswitch system. (Centre) Stability test performed at 60°C through 127 energy storage cycles. (Right) Illustration of MOST power generation concept.

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Investigating molecular solar thermal (MOST) energy storage and release systems under continuous-flow conditions

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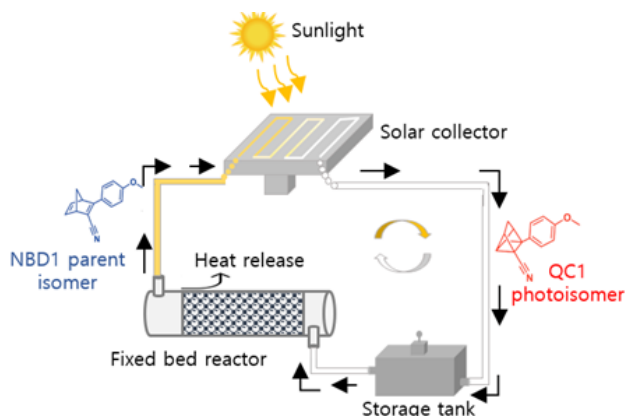
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MOST system consists of employing photo-switchable molecules for solar energy conversion and storage.^[1] Basically, upon irradiation, the photons are absorbed by the parent molecule “A” leading to its isomerisation into a metastable photoisomer “B” (A→B). The difference in energy levels between the two forms, “A” and “B”, corresponds to the energy stored by the couple. This energy is then released, on-demand and at ambient temperature, as heat during the back reaction (B→A), triggered by external stimuli (such as catalysts). Within this context, the ANR SOLPHOTOCAT project aims to develop novel, cheap and environmentally friendly chemical systems, and continuous-flow milli-fluidic devices to rapidly evaluate their performances in the entire solar energy system (storage and conversion).

In the present work, the NBD1/QC1 benchmark system was investigated under continuous-flow conditions using cyclopentyl methyl ether (CPME) as green solvent. Experiments related to the photochemical step (NBD1→QC1) were performed in a spiral-shaped reactor (made of a FEP tube with inner diameter of 0.5 or 1 mm) irradiated by a 365 nm UV LED array. A 1D representation model was developed to predict the experimental data, showing an excellent agreement whatever the operating conditions (photon flux, residence time, initial concentration, tube diameter). A jacketed batch stirred reactor was first used to measure the kinetics with different millimeter-sized catalysts, placed in a stationary basket. These catalysts included commercial Pt/Al₂O₃ spheres (0.5 wt% Pt),^[2,3] as well as Co(II) phthalocyanine complexes supported



on granular activated carbon (CoPc@GAC) and on mesoporous carbon extrudates (CoPc@MC), synthesized at LCC-Toulouse. Using the obtained batch kinetic data, a fixed bed reactor was then designed, and the QC1→NBD1 back reaction could be successfully transferred towards continuous flow conditions. At last, a continuous-flow milli-fluidic process integrating both the photochemical and the back-conversion steps in series was implemented, capable of undergoing successive cycles. In the future, it will be used to study new MOST systems.

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