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The CNRS-Summer School PHOTOCHEM on Preparative and Applied Photochemistry from 16th to 21st September 2018 in Anglet, France.

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Over the last decade, photochemistry has seen a remarkable comeback with significant contributions to green chemistry, organic synthesis, waste treatment, chemical engineering, continuous-flow technologies and new light sources.¹ At the same time, the neglect of this research area by academia as well as industry has caused an urgent need for training in photochemical principles, reactor engineering and applications. Historically, France has been a key location in photochemical research and manufacturing.^{2,3} The first comprehensive Summer School on Photochemistry, chaired by Dr Karine Loubière, was thus organized as an École Thématique of the Centre National de la Recherche Scientifique (CNRS). The event took place between September 16th and 21st 2018 at the Atlantic seaside location of Anglet in the Southwest of France (Fig. 1).⁴



Figure 1. Logo of the CNRS-Summer School PHOTOCHEM.

The main objective of the CNRS-Summer School was to offer high quality and multidisciplinary training in photochemistry. The scientific program was primarily intended for professionals in chemistry related areas, but in particular to:

- Chemists, especially those involved in green and sustainable chemistry, as the provided training in photochemical technologies and engineering enabled them to select the most suitable reactor, light source and operating conditions for any future applications.
- Chemical engineering specialists, who wanted to complement their professional skills with a fundamental knowledge of photochemical concepts and applications, and the subsequent impact on reactor engineering (considering radiative transfer in the reaction medium).
- All current (or potential future) users of photochemistry, particularly in research areas outside organic synthesis (health, materials, environment etc.).

The event was split into 5 modules with a total of 19 talks over 4 ½ days, delivered by 16 professionals from academia and industry, and a workshop & demonstration session. The topics covered fundamental concepts, organic synthesis, technologies, engineering and related applications of photochemistry (Table 1).

| Module 1: Fundamental concepts of photochemistry | |
|--|---|
| 1.1 | Light absorption, electronically excited states, absorption spectra <u>Prof Thierry Pigot</u> , Univ. Pau Pays de l'Adour, IPREM, Pau, France |
| 1.2 | Photophysical deactivation of excited states, energy transfer and photochemical reactions <u>Dr Sylvie Lacombe</u> , CNRS, IPREM, Pau, France |
| Module 2: Applications of photochemistry in organic synthesis | |
| 2.1 | Structural diversity and molecular complexity through organic photochemical reactions <u>Dr Norbert Hoffmann</u> , CNRS, ICMR, Reims, France |
| 2.2 | Photoredox catalysis <u>Prof Louis Fensterbank</u> , Sorbonne Univ., IPCM, Paris, France |
| 2.3 | Sensitized photooxidations <u>Dr Esther Oliveros</u> , CNRS, France |
| 2.4 | Photopolymerization processes: State of the art, trends, perspectives <u>Prof Jacques Lalevée</u> , Univ. Haute-Alsace, IS2M, Mulhouse, France |

| | |
|---|---|
| 2.5 | Industrial photochemistry: An appraisal <u>Prof André M. Braun</u> , Karlsruhe Institute of Technology, Germany |
| Module 3: Photochemical technologies | |
| 3.1 | Laboratory-scale photochemistry: Reactors and light sources <u>A/Prof. Michael Oelgemöller</u> , James Cook Univ., Townsville, Australia |
| 3.2 | Safety issues of industrial photochemistry and adequate responses <u>Alexander C. Peschl</u> , CEO, Peschl Ultraviolet GmbH, Mainz, Germany |
| 3.3 | Solar Photochemistry <u>A/Prof. Michael Oelgemöller</u> , James Cook Univ., Townsville, Australia |
| 3.4 | Microstructured technologies and flow photochemistry <u>Dr Karine Loubière</u> , CNRS, IGC, Toulouse, France and <u>A/Prof. Michael Oelgemöller</u> , James Cook Univ., Townsville, Australia |
| 3.5 | LED and OLED Technologies <u>Laurent Massol</u> , CEO, LED Engineering Development, Montauban, France |
| 3.6 | 3-6 Practical workshop and demonstrations various exhibitors |
| Module 4: Photochemical reactor engineering | |
| 4.1 | Design and dimensioning of industrial photochemical equipment <u>Prof André M. Braun</u> , Karlsruhe Institute of Technology, Germany |
| 4.2 | Physics and place of radiative transfer in the modeling of photoreactors for conception and optimization purposes <u>Prof Jean-François Cornet</u> , SIGMA Clermont, Institut Pascal, Clermont-Ferrand, France |
| 4.3 | Integral formulation and Monte Carlo method for the simulation of radiation transfer in photoreactors of any geometry <u>Dr Jérémie Dauchet</u> , SIGMA Clermont, Institut Pascal, Clermont-Ferrand, France |
| 4.4 | Influence of hydrodynamic conditions in photoreactor modeling and its application in flow photochemistry <u>Dr Karine Loubière</u> , CNRS, IGC, Toulouse, France |
| Module 5: Environmental, energy, material and medical applications | |
| 5.1 | Environmental and energy applications of photocatalysis <u>Dr Nicolas Keller</u> , CNRS, ICPEES, Strasbourg, France |
| 5.2 | Photoswitchable materials and systems <u>Dr Rémi Métivier</u> , CNRS, PPSM, Cachan, France |
| 5.3 | Photodynamic therapy in medicine <u>Prof Gilles Lemerrier</u> , Univ. Reims Champagne-Ardennes, ICMR, Reims, France |

Table 1. Program and speakers of the CNRS-Summer School on Photochemistry.

A highlight and well received event of the PHOTOCHEM Summer School was the practical workshop, which enabled all participants to experience photochemical reactors and light sources for themselves and to interact with experts from industry, research and education. The displays included home-made laboratory equipment as well as commercial devices. The participants were split into small groups and subsequently rotated through the 6 stations over a 2 hours period (Table 2).

| | |
|---|--|
| <p>Station 1: Laboratoire de Génie Chimique (LGC) (Robbie Radjagobalou and Dr Jean-François Blanco) <i>Polymeric tube LED-driven microreactors for laboratory photochemistry</i></p> |  |
| <p>Station 2: Corning (Dr Marc Winter) <i>Laboratory and mesoscale microstructured photoreactors</i></p> |  |
| <p>Station 3: Institut des Sciences Analytiques et Physico-Chimique pour l'Environnement et les Matériaux (IPREM) (Dr Mickaël Le Behec) <i>Reactor for standardized tests of photocatalytic materials for NO_x removal</i></p> |  |
| <p>Station 4: Peschl Ultraviolet GmbH (Alexander C. Peschl) <i>Industrial photochemical technologies and their design</i></p> |  |



| | |
|--|--|
| <p>Station 5: LED Engineering Development (Laurent Massol) <i>LEDs and LED panels</i></p> |  |
| <p>Station 6: Laboratoire de Chimie de Coordination (LCC/ENSIACET) (Dr Odile Dechy-Cabaret) <i>Teaching and training of microscale organic synthesis: A common chemistry/ chemical engineering tool</i></p> |  |

Table 2. Program and exhibitors of the practical workshop and demonstrations.

The Summer School was fully booked with 55 participants, of which 20% came from industry (Arkema, Minakem, Corning, Firmenich and Peshl UV), 53% were academic researchers, 20% were PhD students or postdoctoral fellows and 7% were engineers and technicians (Fig. 3). Upon registration, all participants were asked to provide a short paragraph on their research background & interests. 76% of the participants came from a Chemistry discipline, but 23% had a Chemical Engineering background. While the majority of the participants came from France, 4 participants came from Germany, Switzerland or Australia, respectively.



Figure 3. CNRS-Summer School Picture.

Overall, the CNRS-Summer School PHOTOCHEM was a huge success with lively discussions and engaging interactions between participants and speakers. It clearly demonstrated a strong interest in all aspects of photochemistry. The Summer School delivered high-level teaching and training of photochemical principles, technologies, photoreactor engineering and applications to industrial and academic participants. It is hoped that the Summer School will be repeated in the foreseeable future and will be offered to a broader European audience.

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