


Short communication

Advancing the field of colored and emissive materials: 6th IC³EM, Unveils the future and Evolution[☆]

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The IC³EM conference series embarked on its inspiring journey in 2014 in the picturesque seafaring village of Costa de Caparica, Portugal. Over the course of six captivating editions, it has become a beacon for exploring groundbreaking advancements in synthetic methods and innovative applications of dyes and pigments. Each event has showcased the latest in Organic Dyes, Inorganic Complexes, Drugs, Solar Cell Materials, Solar Concentrators, Sensors, Chemosensors, Nanomaterials, New Dyes and Colorants, Textiles, as well as Organic-Inorganic Hybrid Colored Materials.

These topics are not just fascinating—they are the cornerstone of industrial and technological innovation, elevating the conference's importance on the global stage. Building on its legacy of excellence, the 6th edition of IC³EM, held in July 2024, brought the world back to the enchanting shores of Costa de Caparica, Portugal. This remarkable event was a celebration of innovation, collaboration, and the transformative power of advanced materials.

The conference thrived with the energy and insights of an exceptional group of 178 scientists, representing 27 countries and every continent. Their in-person participation created a vibrant atmosphere of exchange and discovery, exemplifying the spirit of global scientific progress (Fig. 1).

The study of color and light, with its myriad manifestations, lies at the heart of countless scientific disciplines. From unraveling the principles of optics to designing cutting-edge lighting solutions and uncovering the psychological impacts of color, the insights drawn from this vibrant field are as diverse as they are transformative. The conference spotlight groundbreaking research and trailblazing applications, redefining how we perceive and harness-colored materials, light, and color technologies.

In today's fast-paced world of innovation, photonics and imaging have emerged as essential pillars of technological advancement. The

IC³EM-2024 conference has illuminated a wide spectrum of topics, from the mesmerizing interplay of light and color to the vital roles of sensors in medicine, biology, and engineering. This comprehensive scope bridges disciplines, driving both scientific discovery and practical innovation, making IC³EM-2024 an unmissable event for pioneers and visionaries in these fields.

The theme of this edition's conference—"Illuminating the Future"—underscores our commitment to fostering interdisciplinary collaboration and inspiring breakthroughs. By examining the latest research and developments in these interconnected areas, the series of IC³EM conferences aims to propel the advancement of technologies that enhance our understanding of the colours universe and improve the quality of life for people around the world.

In 2024, the IC³EM conference marks a momentous 10-year anniversary—a decade of scientific excellence and collaboration. This milestone event is far more than a series of presentations; it is a vibrant forum where ideas converge, collaborations flourish, and networks are forged across continents.

We had the privilege of hosting an extraordinary team of distinguished speakers, acclaimed researchers, and visionary industry leaders who shared their expertise and pioneering insights. Their contributions sparked fresh perspectives, fueled engaging discussions, and elevated this edition into a dynamic celebration of innovation, collaboration, and the boundless potential of scientific discovery.

The conference featured an inspiring lineup of eleven distinguished plenary speakers who brought their groundbreaking expertise to the forefront of the event. Prof. Todd Marder from Julius-Maximilians-Universität Würzburg (Germany) ([1]) opened the proceedings with a captivating exploration of boron-containing optical materials, setting the tone for an intellectually stimulating experience. Following him, Prof. Xiang Ma from The East China University of Science and

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Technology (China) ([2]) delved into the fascinating realm of Assembling-Induced Emission.

Prof. Denis Jacquemin from Nantes Université (France) ([3]) offered an enlightening discussion on *ab initio* calculations of fluorescence quantum yields, while Prof. Tsuyoshi Minami from The University of Tokyo (Japan) ([4]) introduced innovative pattern recognition-driven chemosensing based on self-assemblies. Later, Prof. Andrea Pucci from the University of Pisa (Italy) ([5]) showcased groundbreaking work on effective light exploitation through materials, with applications in sensors and solar collectors.

Later on, Prof. Clément Cabanetos from the University of Angers, CNRS (France) ([6]) delivered an engaging talk on the upcycling of benzothioxanthene imide dye, aptly titled "From Oblivion to Recognition." Prof. Nelsi Zacheroni from the University of Bologna (Italy) ([7]) followed with a presentation on luminescent responsive materials for health and environmental applications.

Last sessions were equally remarkable. Prof. Alexander Demchenko from Yuri Fedkovych National University in Chernivtsi (Ukraine) ([8]) shared his pioneering results on dual emission and λ -ratiometric detection in analytical fluorimetry. Prof. Holger Stephan from Helmholtz-Zentrum Dresden-Rossendorf (Germany) ([9]) inspired attendees with a presentation on utilizing photons to detect tumors, a cutting-edge approach in medical imaging.

The conference concluded with an outstanding lecture by Prof. Ramón Martínez Máñez from the Polytechnic University of Valencia (Spain) ([10]), who captivated the audience with his innovative work on chromo-fluorogenic probes and their versatile applications. Each speaker enriched the event, making this edition a true celebration of scientific innovation and collaboration.

Twenty-two keynote speakers: Pier Luigi Gentili (Italy), Tarita Biver (Italy), Takashi Hayashita (Japan) Beatrice Delavaux-Nicout (France), Nasim Sabouri (Sweden), Franz-Josef Meyer-Almes (Germany), Hironoru Kaji (Japan), Mark Thompson (USA), Thomas J. Muller (Germany), Ivo Piantanida (Croatia), Yui Sasaki (Japan), Yin Bao (Switzerland), Sylvain Achelle (France), Masahiro Goto (Japan), Atanas Kurutos (Bulgaria), Claudio Roscini (Spain), Nuno Moura (Portugal), Pablo Gabiña (Spain), Maria Helena Godinho (Portugal), and Lionel Sanguinet (France) as well as 53 oral welcome speakers, 23 shotgun presentations and 56 poster communications, completed the outstanding edition.

This special issue, titled "Advancing the Field of Colored and Emissive Materials: 6th IC³EM, Unveiling the Future and Evolution," highlights the remarkable achievements stemming from collaborative efforts across Belgium, Brazil, Bulgaria, Croatia, China, France, Italy, Japan, Portugal, Republic of Korea, Russia, Spain, Singapore, Ukraine, and Vietnam. It reflects the global spirit of scientific innovation and the synergy that drives progress in these transformative fields.

As part of this exceptional edition, the IC³EM 2024 PROTEOMASS Scientific Society Career and Scientific Awards recognized extraordinary contributions to the field. The prestigious "Career Award" was presented *ex-aequo* to Prof. Todd Marder (Julius Maximilian's Universität

Würzburg, Germany), Prof. Nelsi Zacheroni (Università degli Studi di Bologna, Italy), and Prof. Aleksandr Petrovich Demchenko (Yuri Fedkovych National University, Ukraine), honoring their lifetime achievements and groundbreaking work.

The "Young Career Emerging Leaders Under 40 Award" celebrated rising stars in the field, with accolades awarded *ex-aequo* to Prof. Clément Cabanetos (University of Angers, France) and Prof. Tsuyoshi Minami (The University of Tokyo, Japan), recognizing their innovative contributions and promise as future leaders (Fig. 2).

This special issue serves as a testament to the inspiring global efforts and individual excellence shaping the future of colored and emissive materials, solidifying the role of the IC³EM as a catalyst for scientific advancement and collaboration. T. E. A. Frizon and coworkers describes the synthesis of new naphthalene diimide from the reaction between 1,4,5,8-naphthalenetetracarboxylic dianhydride (NTCDA) and different *p*-alkoxy-substituted anilines. Electrochemical studies indicates that the presence of different alkyl chains significantly affects the capacity of NDIs when used as organic cathodes in Al-graphite batteries due to variations in their ability to intercalate tetrachloroaluminate [11].

A. Pucci and coworkers reported four new organic fluorophores, derived from central 9*H*-carbazole (CBZ) or indolo [3,2-*b*]indole (IDID) moiety, functionalized with (*S*)-3,7-dimethyl-1-octyl branched chains and connected to lateral 2-thienylethynyl or 2-thiophenylpropynone units for potential application in luminescent solar concentrator (LSC) systems [12]. Two new tetra-dansyl derivatives incorporating cyclen (1,4,7,10-tetraazacyclododecane) and cyclam (1,4,8,11-tetraazacyclotetradecane) macrocycles have been reported by A. Kurutos, C. Lodeiro and coworkers' high sensitivity to Cu²⁺ and Hg²⁺ ions. The authors presented the photophysical properties in solution and in the solid state [13].

S. Lee and coworkers presented some coumarin probes to enhance PDT applications, integrating a protonatable lysosome-targeting moiety and the formation of bovine serum albumin (BSA)-based nanoparticles [14].

A Bimodal magnetic-fluorescent materials integrating magnetic and fluorescent properties have been reported by J. Vidal-Gancedo *et al.*, with potential applications in biomedical imaging, biosensing, and therapeutic diagnosis [15]. The group of F. Pina reported the pH-dependent thermodynamics and kinetics of two new aminoflavylium compounds 4'-(*N,N*-dimethylamino)-7-hydroxyflavylium (4'NMe₂7OH) and 4'-(*N,N*-diethylamino)-7-hydroxyflavylium (4'NEt₂7OH) in water in the absence and presence of β -CD [16]. A. Tatartsev's team presented a series of novel heptamethine cyanine dyes and their photophysical properties [17].

N. Moura and coworkers studied a series of bis-cyclometalated iridium (III) complexes featuring porphyrin-arylbiopyridine ligands into poly (vinylpyrrolidone) (PVP) micelle. This integration resulted in photostable PVP-PS formulations with a remarkable capability to generate singlet oxygen [18]. Two new fluorescent probes 2-(2-bromoethoxy)-9,10-diphenylanthracene and 9,10-diphenylanthracene were reported by I. Crnolatac and coworkers for their suitability to

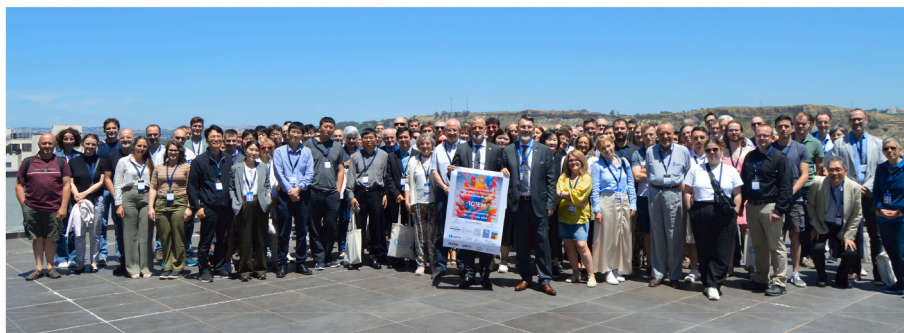


Fig. 1. 6th IC³EM 2024 delegate group.



Fig. 2. The 6th IC³EM 2024 PROTEOMASS Scientific Society Career Award and Career Emerging Leaders Under 40 Award, 2024 ceremony. Ceremony pictures during the Gala Ceremony in Costa de Caparica, Portugal. From left to right, Carlos Lodeiro, Tsuyoshi Minami, Clement Cabanetos, Nelsi Zaccheroni, Todd B. Marder, Aleksander Demchenko, and Jose Luis Capelo-Martínez.

report temperature-induced phase transitions in phospholipid formulations [19]. H. Kim and coworkers developed a new lead-free perovskite tandem for solar cells applications with ZnO moth-eye antireflection [20].

N. Belskaya's Team reports the synthesis of new spirocyclic boron-coordinated (SBCs) fluorophores based on a simple and facile procedure and their optical properties [21].

J. Buñuelos *et al.* reports a new family of benzo [f]indazoles able to absorb light and convert it into glow blue fluorescence. The photonic performance of these benzo [f]indazole-based dyes surpasses coumarines, considering as benchmark in the same spectral window, yielding brighter and long-lasting emission even under intense and prolonged illumination [22].

A. Dos Santos and coworkers report a synthetic route for a new Seleno-BODIPY compound to act as a fluorescent probe by reaction with biological thiols in living cells. The probe presented high selectivity for biothiols between 26 analytes of biological interest. Distinct responses for Cys and GSH by colorimetric and fluorometric analysis in a turn-on fluorescent process was reported [23]. J. Rodríguez-López *et al.* present a new family of 6-aryl-2,4-bis(2'-hydroxyphenyl)pyrimidines synthesized and characterized using Suzuki-Miyaura reactions. The authors have demonstrated their ability to function as rigid tridentate O⁻N⁺O chelating ligands for the preparation of four-coordinate organoboron compounds. Protonation and boron complexation can successfully inhibit the ESIPT process, resulting in fluorescence recovery, which can be finely tuned by modifying the substituents on the aryl group [24].

Several vegetable oils including, *Persea gratissima* (avocado oil, AO), *Mauritia flexuosa* Linnaeus filius (buriti oil, BO), *Passiflora edulis* (passion fruit oil, PFO), and *Plukenetia volubilis* L. (Sacha inchi oil, SIO) have been thermos-optical characterized by V. Pilla and coworkers. The authors highlight that vegetable oils are nontoxic, nonvolatile, nondepletable, and biodegradable resources employed for many applications, among them foods, cosmetic, lubricant, coating, and pharmaceutical industries, due to their possible antioxidant and antimicrobial activities [25]. S. Lee's team studied a novel and straightforward method for synthesizing a photothermal small molecule, PA2, utilizing a donor-acceptor framework. In vivo experiments in a mouse tumor model demonstrate the favorable biocompatibility of their photothermal small molecules, signifying their suitability for safe application in biomedical contexts [26]. T. Hayashita and coworkers reported a supramolecular complex formed by a dipicolylamine copper complex with an azobenzene group and phenylboronic acid-modified cyclodextrin for adenosine 5'-diphosphatam (ADP) recognition in water [27]. Y. Nishimura and coworkers investigate the effect of proton acceptors on the excited-state intermolecular proton transfer (ESPT) reaction of fluoranthene-urea compounds, three fluoranthene-urea compounds with different substituents [28]. Finally, J. Xu team reports on the synthesis of two fluorinated electron acceptors using an inverse electron demand Diels-Alder reaction, demonstrating the fluorinated electron acceptors

play a vital role in the development of conjugated polymers enhancing the performance of electrochromic devices [29].

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As we embark on this intellectual journey together, we are confident that IC³EM will serve as a catalyst for inspiration and innovation in the field of Dyes, Pigments and Applications. We encourage all of you to engage actively, sharing your knowledge, and explore new horizons in this fascinating research field.

The guest editors extend their heartfelt gratitude to all the authors and co-authors for their exceptional contributions to this collection of papers (Special Issue). We sincerely hope that this SI will serve as a valuable resource for the next generation of researchers in the fields of colorants, dyes, emitters, solar cell concentrators, drugs and sensors.

Finally, we are grateful to the Dyes and Pigments editors-in-chief, Professor Mark Heron, Professor Mark Wainwright, and to Ms Carla Gao (Dyes and Pigments Publisher), Mr. Antony J.C Nathaniel (Dyes and Pigments, Editorial Office) for their help and support to prepare this special issue dedicated to the sixth edition of the International IC³EM-2024 conference.

During the preparation of this work the author(s) used ChatGPT-Openai to improve language and readability. After using this tool/service, the author(s) reviewed and edited the content as needed and take (s) full responsibility for the content of the publication.

CRediT authorship contribution statement

Carlos Lodeiro: Conceptualization, Formal analysis, Funding acquisition, Project administration, Validation, Writing – original draft, Writing – review & editing. **José Luis Capelo-Martínez:** Conceptualization, Formal analysis, Funding acquisition, Supervision, Validation, Visualization, Writing – review & editing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Carlos Lodeiro reports financial support was provided by Proteomass Scientific Society. I am an Executive Editor of Dyes and Pigments, Guest Editor of the Special Issue IC³EM 2024. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

No data was used for the research described in the article.

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