SCHOOL OF CHEMISTRY
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SEMINAR

Name of the Speaker	Dr. Amit Biswas, Laboratoire Lorrain de Chimie Moléculaire (L2CM), Université de Lorraine, CNRS, France
Title of the Talk	A Journey from Electron Transfer to Adaptive Catalysis for Greenhouse Gas and Super-Strong Bond Activation
Date & Time	12.08.2026 (Wednesday) 4 PM
Venue	PhD Classroom, SoC

ALL ARE INVITED

Date: 10/08/2026

Faculty In-charge

A journey from electron transfer to adaptive catalysis for greenhouse gas and super-strong bond activation

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Keywords: Phenalenyl, Mechano-SSET, Electro-photocatalysis, N_2-functionalization, C-F bond, Multi-PET, CO_2 & N_2O functionalization, Adaptive catalysis

Abstract: The metal-free approach to electron transfer catalysis effectively replicates electron transfer pathways similar to those of transition metals, facilitating its application in various organic transformations. This form of electron transfer catalysis, with or without external stimuli, has emerged as a compelling subject in recent decades. In this study, I utilized the smallest odd-alternant hydrocarbon unit, phenalenyl (PLY), alongside the organic chromophore bis(borondifluoride)-8-imidazodipyrromethene (BOIMPY) system for transition metal-free electron transfer catalysis. Notably, the PLY system can exist in three distinct redox states: closed-shell cation, mono-reduced open-shell neutral radical, and doubly reduced closed-shell anion states. My research focuses on a solid-state electron transfer catalytic strategy based on the anionic form of the phenalenyl moiety under solvent-free ball milling conditions, targeting the cleavage of strong carbon-halogen (C-X) bonds (X= I, Br, Cl), which results in the formation of the corresponding aryl radicals. Furthermore, doubly reduced PLY was generated electrochemically, and its photoexcited state produced super-reduced hot electrons with exceptionally high potential. In the presence of Lewis acids, these super-reducing species can reduce dinitrogen gas via an FLP-mediated pathway, producing ammonia and leading to aniline derivatives from aryl halides through a metal-free Buchwald-Hartwig C–N cross-coupling reaction. In addition, the BOIMPY dye, a fluorescent-active compound, exhibits reversible cyclic voltammetry with two successive reduction potentials. The BOIMPY system functions as an electron-transfer catalyst in various organic transformations under photochemical conditions. This dye represents a new generation of reductive photocatalysts known as multiple photoinduced electron transfer catalysis (Multi-PET). Additionally, BOIMPY acts as an electron-transfer catalyst to photochemically activate greenhouse gases such as CO2 and N2O, leading to novel reactions such as the reductive mono-carboxylation of arenes and dihydroxylation of arenes, which subsequently undergo further oxidation to form quinones. By combining both greenhouse gases with the BOIMPY catalyst, we successfully produced useful polyester derivatives that are essential for everyday products.

Recently, adaptive catalysis has garnered significant attention in organic transformations

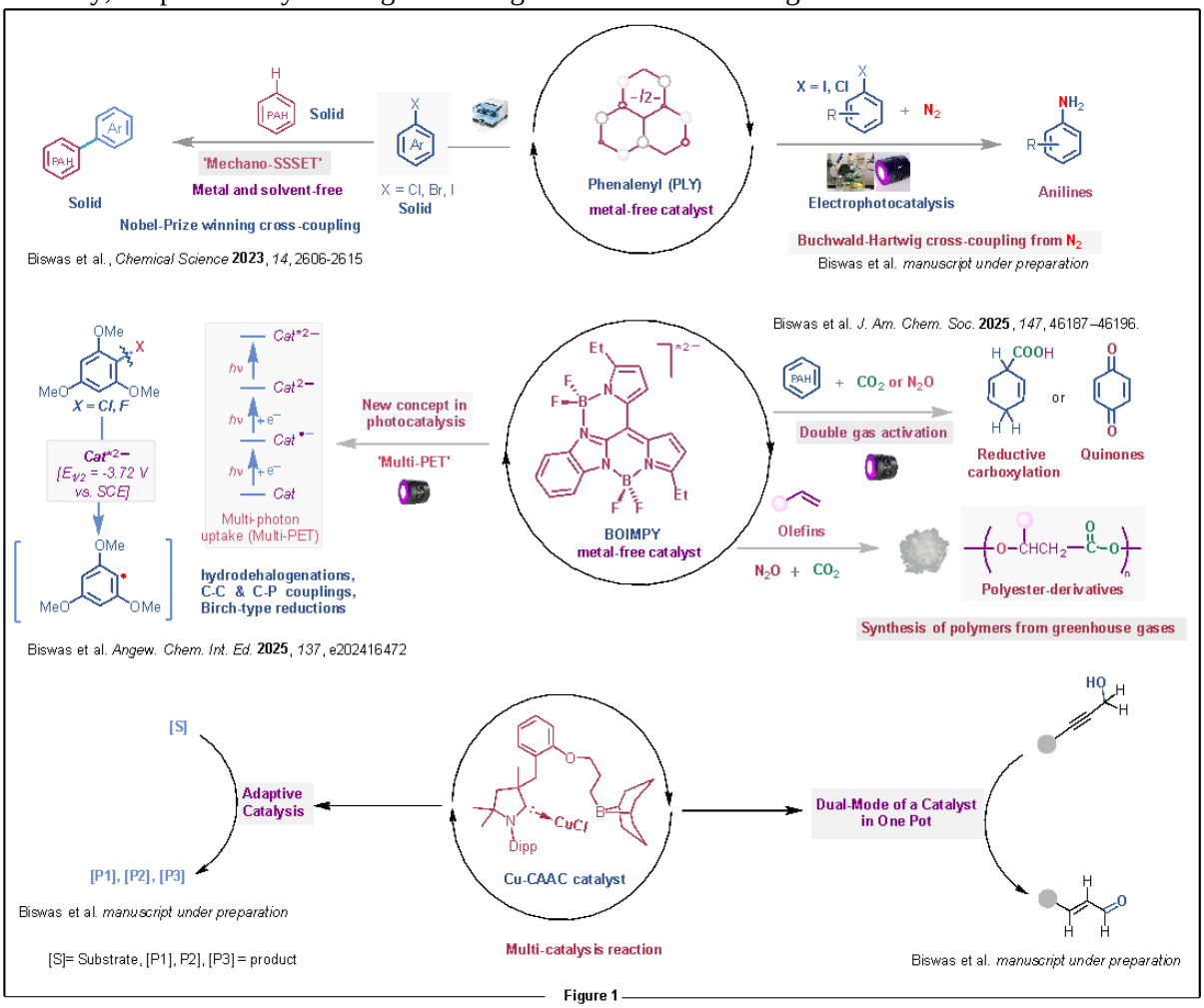

Figure 1

owing to its numerous advantages. Adaptive catalysis encompasses synthetic and biological catalytic systems capable of undergoing rapid and robust reversible changes in their structural or electronic states. These changes occur in response to dynamic variations in the reactive environment, feedstock supply, and energy inputs. Inspired by natural enzymes, these advanced systems overcome the traditional scaling limitations, achieving programmable selectivity and high efficiency. In my current research, Cu-CAAC acts as an adaptive catalyst for the carboxylation and hydrogenation of propargyl alcohol using CO_2 and PMHS. Furthermore, this catalyst demonstrates a novel catalytic concept that integrates oxidation and reduction chemistry in a single-pot process.

Figure 1. General Scheme of Electron Transfer Catalysis and Adaptive Catalysis. Mechano-SSSET: Mechanochemical Solid-State Single Electron Transfer; Multi-PET: Multiple Photoinduced Electron Transfer Catalysis.

Publications:

1. **Biswas** et al. *Chem. Sci.*, **2023**, *14*, 2606-2615.
2. **Biswas** et al. *Angew. Chem. Int. Ed*. **2025**, *137*, e202416472.
3. **Biswas** et al. *J. Am. Chem. Soc.* **2025**, *147*, 46187–46196.
4. **Biswas** et al. Adaptive M (Cu/Rh)-CAAC catalysis with carboxylation and semi-hydrogenation of propargyl alcohols. *Manuscript under preparation*
5. **Biswas** et al. Buchwald-Hartwig cross-coupling from N_2 and aryl halide. *Manuscript under preparation*
6. **Biswas** et al. Dual reactivity of Cu-CAAC catalyst via simultaneous oxidation and reduction of propargyl alcohols. *Manuscript under preparation*