

CHIMIA

CHIMIA 2026, Volume 80

ISSN 0009-4293

www.chimia.ch

Supplementa to Issue 7-8/2026



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SCS Fall Meeting 2026
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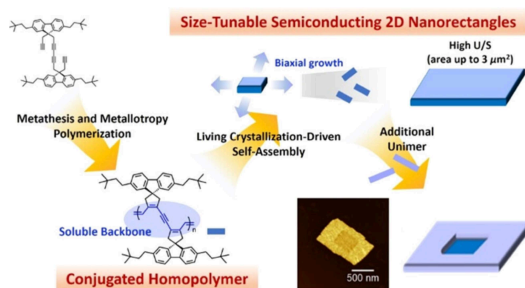
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Size-Tunable Semiconducting 2D Nanorectangles from Conjugated Polyenyne HomopolymerT. Choi¹¹Department of Materials, ETH Zurich, Switzerland

Conjugated polymers are attractive soft materials that have gained a lot of attentions due to their interesting optoelectronic properties. In this presentation, we will focus on the new strategies for the formation of semiconducting 2D nanostructures via self-assembly approach. Conventional polymer adapts random coil conformation while many conjugated polymers are semi-rigid. Furthermore, these conjugated polymers form π - π stacking to one another so they are easily aggregated showing much lower solubility. As a result, due to their high rigidity and crystallinity, controlling their morphologies are challenging. Here, taking advantage of these facts, we designed several diynes monomers containing fluorene side-chains and performed cyclopolymerization using 3rd generation Grubbs catalyst. These new homopolymers of polyacetylene derivatives underwent self-assembly to form various 2D nanostructures which are simply beyond the conventional structures of typical polymers. The resulting nanostructures are characterized by UV-vis, IR, DLS, AFM, TEM, and optical microscopy to obtain the detailed structural information. We will start with how we could control the shape of 2D nanosheets and then discuss how to control their sizes and aspect ratios by combining the concept of crystallization-driven self-assembly. Since conjugated polymers are attractive soft materials for their interesting optoelectronic properties, we hope these new 2D nanosheets would find useful applications in electronic devices.



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New catalytic pathways to functional and recyclable polymersS. Nguyen¹¹EPFL Institute of Chemical Sciences and Engineering, CH-1015 Lausanne

Polymers have transformed modern society thanks to their low cost, durability, and versatility, with applications spanning virtually every sector of daily life. At the same time, their production and end-of-life management present significant environmental challenges. Addressing these issues require new technologies to both polymer recycling and material design. This talk will highlight complementary chemical strategies to advance polymer sustainability, including new approaches to recycling commodity polymers, enhancing the durability and lifetimes of existing materials, and developing catalytic methods to access high-performance, recyclable polymers, from renewable feedstocks. Collectively, these efforts aim to advance fundamental polymer chemistry while contributing to the transition toward a more circular and sustainable polymer economy.

A Streamlined Strategy for the Construction of Oligonucleotide Phosphoramidate LibrariesS. Dana¹, C. Bon¹, C. Sparr¹¹Department of Chemistry, University of Basel, St. Johannis-Ring 19, 4056 Basel, Switzerland

Oligonucleotides and cyclic dinucleotides (CDNs) are emerging therapeutic modalities for the treatment of many previously untreatable diseases. Typically, (oligo)nucleotide backbones are constituted by nucleoside units that are hinged together by phosphate linkages. The strong negative charge of canonical phosphate linkages constrains the therapeutic utility of nucleotide-based modalities by restricting cellular uptake, compromising metabolic stability, and impeding efficient systemic delivery. In this context, the internucleoside phosphoramidate linkages exhibit promising pharmacokinetic properties. Yet, their conventional synthesis has remained a challenge owing to the poor scope of amine nucleophiles and the overreliance on azide-based Staudinger reaction. Developing a divergent platform for the construction of diverse internucleoside linkages across different nucleoside base pairs and suitable for industrial solidphase oligonucleotide synthesis is essential for the advancement of oligonucleotide therapeutics. Here, we present a straightforward and cost-effective synthetic route for the rapid generation of phosphoramidate libraries from commercial reagents. The synthetic protocol provides a divergent platform for the efficient insertion of diverse chemical handles into the dinucleotide backbone, giving access to charged and charge-neutral internucleoside linkages. A diverse array of previously inaccessible phosphorus linkages can now be accessed while avoiding the use of unstable reagents and complex protecting-group manipulations. The current transformative tool allows the synthesis of phosphoramidates in one-pot, both in linear and parallel fashion, starting from commercially accessible nucleosides and avoiding the purification of sensitive phosphoramidite and phosphite intermediates. The strategy is also operative in standard solid-phase oligonucleotide synthetic platform. These findings enable efficient modulation of a range of dinucleotide chimeras for biological evaluation, thereby expediting their advancement as therapeutic agents and biological probes toward clinical translation.

General Platform for Divergent Construction of Phosphorus-Modified DNA/RNA Backbones

C. Bon¹, A. Budeev¹, S. Dana¹, C. Sparr¹

¹Department of Chemistry, University of Basel, St. Johannis-Ring 19, 4056 Basel, Switzerland

Phosphorus-containing biomolecules, including nucleotides, cyclic dinucleotides, and related cofactors, play central roles in signaling, immunity, and enzyme regulation. However, the highly anionic nature of canonical phosphate linkages severely limits the therapeutic potential of nucleotide-based modalities by restricting membrane permeability, metabolic stability, and systemic delivery. While charge-neutral or non-canonical phosphorus linkages offer a promising solution, their development remains constrained by synthetic challenges, limited structural diversity, and poor compatibility with oligonucleotide assembly workflows.

Here, we present a unified and modular platform for the direct modification of phosphorus centers within DNA and RNA backbones. Building on recent advances in organophosphorus radical chemistry, this approach enables the selective engagement of diverse reaction partners under mild conditions, overcoming the reactivity and selectivity limitations typically associated with complex nucleotide substrates. The strategy provides access to a broad range of previously inaccessible phosphorus linkages without relying on unstable reagents or extensive protecting group manipulations.

By decoupling nucleic acid assembly from phosphorus diversification, this platform enables rapid exploration of chemically and functionally diverse backbone architectures. More broadly, it establishes phosphorus as a tunable element for modulating physicochemical and biological properties, opening new opportunities for the development of nucleotide-based probes and therapeutics.

Highly defective perovskite-based catalysts for energy and environment: application in methanol synthesis from CO₂ hydrogenation

C. Pischetola¹, L. Artiglia¹, A. Bugaev¹, F. Talebkeikhah¹, F. Yao¹, V. Sushkevich¹, M. Vanni¹, F. Krumeich¹, J. van Bokhoven^{1,2}

¹Paul Scherrer Institute, Forschungsstrasse 111, 5232, Villigen, Switzerland, ²ETH Zurich, Institute for Chemical and Bioengineering, Vladimir-Prelog-Weg 1, 8093, Zurich, Switzerland

Within the energy and environment sector, perovskites are materials immediately associated to photoand electro-catalytic applications, while largely overlooked by the thermocatalysis community due to their small surface area (<10 m² g⁻¹), despite exceptional structural and electronical tunability [1]. The formation of oxygen vacancies (Ov) from catalyst's partial reduction has proven to be key for the selective production of methanol (MeOH) from carbon dioxide (CO₂) [2]. Given the environmental relevance of CO₂ valorisation into chemicals, finding efficient strategies to optimise the content of Ov on the catalyst surface is pivotal. My research identifies perovskite SrTiO₃ as a next-generation methanol catalyst (see Figure 1). Materials engineering delivered high surface areas SrTiO₃ support (I) with dispersed copper nanoparticles by deposition (Cu/STO, (II)) and from exsolution (SCTO, (III)). From catalytic tests under relevant energysaving conditions, a MeOH selectivity over 96% and STY (mol_{MeOH} mol⁻¹_{Cu} h⁻¹) outmatching that from standard catalyst (CZA) were obtained (IV-V). In-situ/operando tools (XPS, XRD, XAS, FTIR) unveiled the nature of the catalytic sites: coupled Cu + Ov (at the interphase or as isolated clusters). These are dynamic systems whose content is affected by the environment (gas, temperature and pressure) at which the catalyst is exposed (Vi-VII). A direct correlation between the concentration of formate surface intermediate and content of Ov was established (VIII). Our results show the potentiality of the newly developed catalysts.

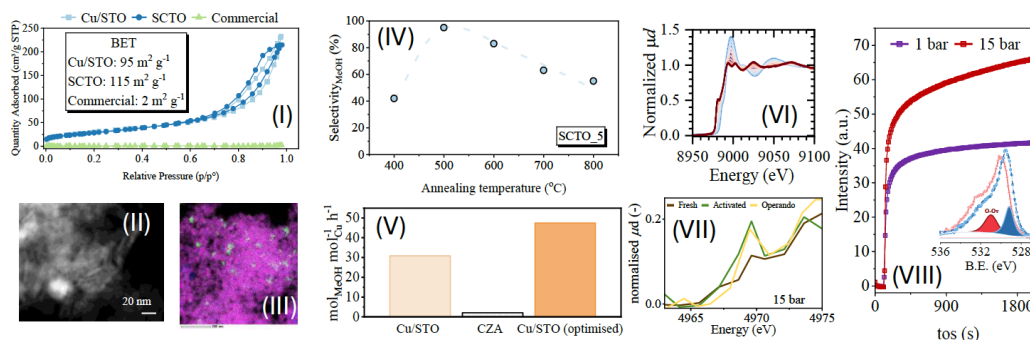


Figure 1. Characterisation and catalytic data from Cu/STO and SCTO materials. **(I)** N₂ Physisorption and BET data; **(II)** TEM and **(III)** EDX images; **(IV)** MeOH selectivity and **(V)** STY from catalytic data; Operando XAS data over **(VI)** Cu K-edge and **(VII)** Ti K-edge; **(VIII)** Formate intensity from operando IR with O 1s from XPS as inset, where the red area component refers to the oxygens close to a Ov.

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Redox targeting and chelate design for next-generation flow batteriesD. Reber¹¹Empa Dübendorf

Building an experimental platform for flow battery research presents many challenges. In this talk, I will share the lessons and insights gained from establishing a junior research group from scratch, with a focus on redox targeting strategies to boost energy density and chelate design for high-power aqueous flow batteries.

The limited solubility of redox-active species in flow batteries can be addressed by adding solid capacity boosters to the electrolyte tanks. A soluble redox mediator is charged or discharged in the electrochemical cell and subsequently reacts chemically with the booster, allowing the use of solid materials whose charge-storage capacities far exceed what is practically attainable by dissolving active species in water. Lithium iron phosphate, for instance, works well as a booster paired with ferrocyanide as the mediator. Although reproducible fabrication of booster granules turned out to be harder than expected, we recently showed that swapping fluorinated binders for biodegradable alternatives improves mediator-solid inter-actions thanks to the lower hydrophobicity of the composite, tripling the reaction rate between mediator and booster.^[1]

For all-liquid designs, we revalidated KCrPDTA as a benchmark negative electrolyte for high-power flow batteries and ran into challenges spanning precursor purity, chromium olation, and recrystallization, as well as membrane ruptures and flow fields absorbing electrolyte. In the process, we found that thermal activation of carbon paper electrodes strongly influences the morphology of bismuth electrocatalysts, which in turn affects parasitic hydrogen evolution and Coulombic efficiency, illustrating how electrode treatments can shift the balance between kinetics and stability.^[2,3]

At the molecular level, we investigated how small structural changes in chelating ligands alter the electronic structure of transition-metal complexes. Adding a hydroxyl group to the PDTA backbone (yielding CrPDTA-OH) introduces subtle geometric distortions that sharply slow electron transfer, emphasizing how important a stable hexacoordinate geometry is for fast, reversible redox processes with these chelates.^[4]

Taken together, these studies link system-level design principles with molecular-level control, offering lessons on how chemistry, processing, and reproducibility intersect in advancing next-generation flow battery materials.

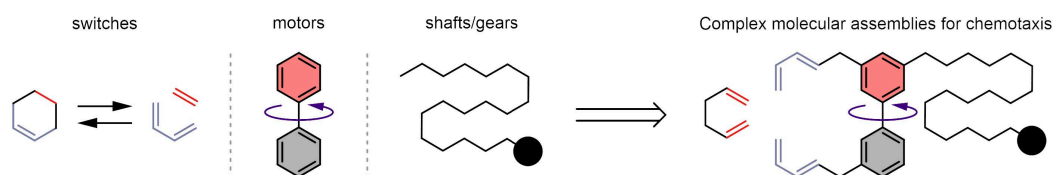
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2. Liu, Q., Kimbell, G., Ahn, J., Camenisch, L., Celik, R., Echeverria, T., Virk, B., Battaglia, C., Reber, D. Revalidating KCrPDTA as flow battery electrolyte, submitted
3. Echeverria, T., Bernasconi, F., Ziemiański, P., Reber, D. Impact of Thermal Electrode Activation on Electrocatalyst Performance in KCrPDTA/K₄Fe(CN)₆ Flow Batteries, *Batteries & Supercaps*, 2024, e202400696
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From Small Machines to Complex Assemblies

E. Olivieri¹

¹Department of Chemistry, University of Basel, St Johannis-Ring 19, Basel 4056, Switzerland

The design and synthesis of molecular machines, and notably chemically fuelled motors, has evolved considerably in recent years ^[1–4]. One fundamental challenge is now to assemble these discrete units into higher-order architectures capable of performing collective work, as exemplified in biology by ATP synthase. Our small team is currently developing elementary machine units—switches and motors—with the aim of integrating them into complex assemblies and devices with applications in endergonic synthesis ^[5], artificial muscles, and smart materials, where nanoscale mechanical motion translates into programmable material behaviour.



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Harnessing Transient Anions and Low-Valent Metals: Mechanistic Pathways to Challenging TransformationsA. Tortajada¹¹Chemistry Department, University of Fribourg, Chem. du Musée 9, Fribourg, Switzerland
andreu.tortajadanavarro@unifr.ch

Carbon–carbon (C–C) and carbon–heteroatom (C–X) bond formation remain the cornerstones of organic synthesis. However, accessing unexplored chemical space requires reaction modes that transcend established catalytic paradigms. In this context, π -systems offer a versatile platform for bond construction, particularly through cycloaddition and electrocyclization processes that can rapidly build molecular complexity.^{1,2}

Here, we present a dual approach to unlocking unconventional π -reactivity by leveraging distinct activation modes. First, high-reactivity alkali-metal catalysts generate transient anionic intermediates, such as heptatrienyl species; these undergo efficient ring closure to yield challenging architectures, including 7- membered carbocycles derived from biobased monoterpenes.³ In parallel, low-valent cobalt complexes can enable selective cycloaddition and C–C/C–X bond-forming reactions with olefins and small molecules. In these systems, precise control over oxidation state and electronic structure grants access to reactivity patterns unattainable with traditional catalysts.

By merging the potent reactivity of alkali metals with the controlled coordination chemistry of low-valent transition metals, this work establishes new pathways for π -system functionalization. Our mechanistic insights provide a foundation for expanding the scope of cycloaddition chemistry and streamlining the synthesis of more complex molecular architectures with organometallic species.

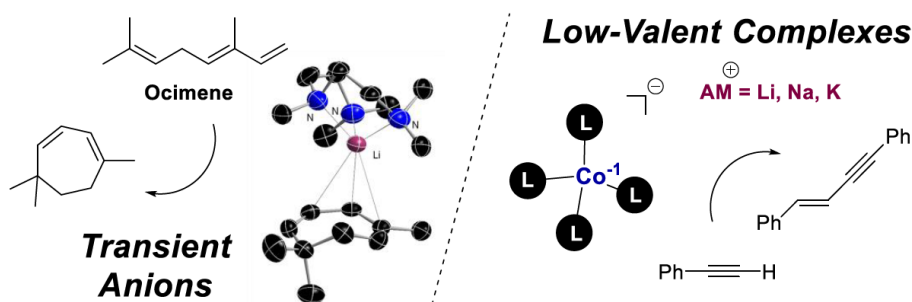


Figure 1. Harnessing Transient Anions and Low-Valent Metals for Catalytic Applications.

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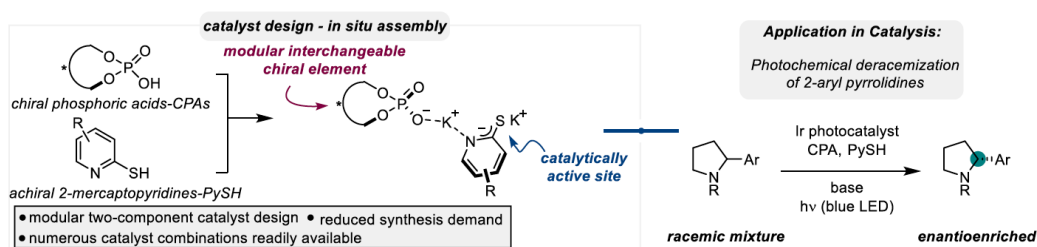
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Enantioselective Hydrogen Atom Relay via Non-covalent Catalyst Assembly

G. Zuccarello¹, N. Yalamanchili¹, J. Alexandre¹

¹Ecole Polytechnique Fédérale de Lausanne (EPFL), Av. Forel 2, 1015 Lausanne/CH

Hydrogen atom transfer (HAT)^[1] is a powerful technology in organic synthesis especially when coupled with photoredox catalysis. However, inducing enantioselectivity in these transformations proceeding through neutral radical intermediates is an outstanding challenge.^[2] The major impediments are represented by the scarce amenability of HAT catalysts for asymmetric design and by controlling the highly reactive and short-lived open-shell intermediates in a chiral microenvironment.^[3] While traditional approaches to chiral catalyst design rely on constructing a covalent chiral environment around the active site, we have disclosed a distinct approach. We have paired chiral phosphate ions, derived from privileged chiral phosphoric acids with commercial 2-mercaptopyridines.^[4] The chiral counterions render the achiral HAT catalysts (2-mercaptopyridines) effectively chiral.^[5] The two-component catalyst design is highly tunable and interchangeable, giving potentially access to numerous chiral HAT catalysts while maintaining a low synthesis demand. We have applied our conceptual catalyst design to the photochemical deracemization of 2-aryl pyrrolidines, a prevalent subunit in active pharmaceutical ingredients. Mechanistic studies reveal that ion-pairing is the main non-covalent interaction shaping the assembly and that enantioenrichment occurs via enantioselective hydrogen atom relay in which the chiral HAT assembly induces enantioselectivity in hydrogen atom abstraction and delivery.



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