Swiss Science Concentrates

A CHIMIA Column

Short Abstracts of Interesting Recent Publications of Swiss Origin

Synthesis, Characterization, and Reactivity of a Hypervalent-Iodine-Based Nitrooxylating Reagent
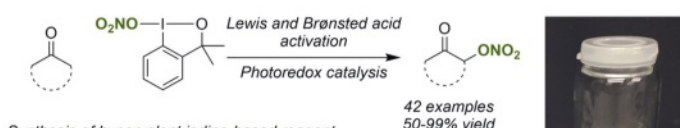
R. Calvo, A. Le Tellier, T. Nauser, D. Rombach, D. Nater, and D. Katayev,* *Angew. Chem. Int. Ed.* **2020**, *59*, 17162.
ETH Zurich, University of Geneva

The nitrooxy (-ONO_2) group is very interesting as an NO donor for the modification of pharmacophores. However, the existing methodologies to access organic nitrates are limited by the requirement for prefunctionalized starting materials and harsh reaction conditions. Herein, the authors report a readily accessible hypervalent iodine-based nitrooxylating reagent, which allows the direct and selective nitrooxylation of a range of enolizable C–H bonds under mild conditions. The nitrooxylation of 1,3-dicarbonyl compounds involved activation of the reagent by a Brønsted or Lewis acid and occurred *via* the reductive elimination mechanism. In contrast, the nitrooxylation of oxindoles was performed under photoredox catalysis, and a unique single-electron-transfer-induced concerted mechanistic pathway was proposed upon detailed mechanistic studies.
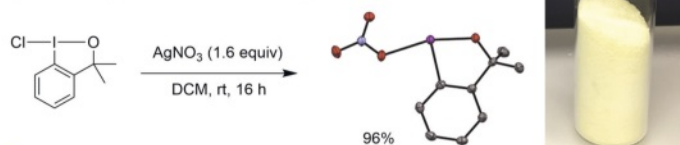
Authors' comments:
"We hope that the mechanistic insights in combination with the physical properties of the reagent presented in this work will open up a wealth of opportunities for future reaction development towards a facile introduction of the –ONO_2 group onto various organic scaffolds including biologically active compounds."
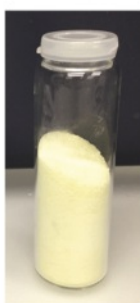
Palladium-Catalyzed Chlorocarbonylation of Aryl (Pseudo)Halides Through In Situ Generation of Carbon Monoxide

P. Boehm, S. Roediger, A. Bismuto, and B. Morandi* *Angew. Chem. Int. Ed.* **2020**, DOI: 10.1002/anie.202005891.
ETH Zurich

Over the years, palladium-catalyzed carbonylation chemistry has proven to be a robust tool in the synthesis of various commodity chemicals and pharmaceuticals. However, it usually involves pressurized carbon monoxide gas, which complicates implementation at the laboratory scale. In this work, Morandi and co-workers report a facile and general protocol to convert aryl (pseudo) halides to their corresponding acid chlorides. Butyryl chloride was employed as a cheap source of CO and chloride, thereby bypassing the use of exogenous carbon monoxide. A range of aryl bromides, iodides and scarcely reported triflates were efficiently converted to acid chlorides and other carbonyl derivatives in a one-pot fashion. Experimental and computational investigations indicated that this reaction proceeds *via in situ* CO generation from butyryl chloride and incorporation into the aryl (pseudo) halide.
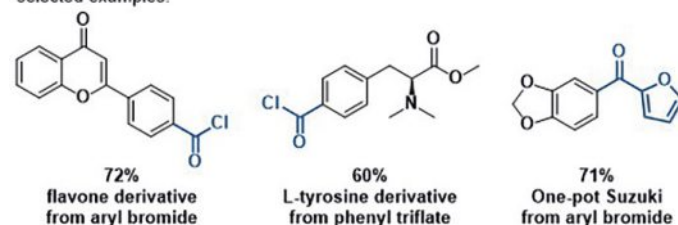
Authors' comments:
"We have developed a user-friendly alternative to the use of exogenous carbon monoxide in the catalytic synthesis of acid chlorides. In light of the group's synthetic versatility, we hope that this reaction will streamline the synthesis of important carbonyl-containing products."

Nitrooxylation of carbonyl compounds

Synthesis of hypervalent iodine-based reagent

96%

- stable in protic and aprotic solvents
- crystalline solid • bench stable • can be handled under air
- safety evaluated by DSC/TGA • synthesis of new classes of nitrate esters

42 examples
50-99% yield

- safe reaction set-up - high functional group tolerance -
- mechanistic experiments - computational studies -

selected examples:

72%
flavone derivative
from aryl bromide

60%
L-tyrosine derivative
from phenyl triflate

71%
One-pot Suzuki
from aryl bromide

## Large-Cavity Coronoids with Different Inner and Outer Edge Structures

M. Di Giovannantonio,* X. Yao, K. Eimre, J. I. Urgel, P. Ruffieux, C. A. Pignedoli,* K. Müllen,* R. Fasel, and A. Narita,* *J. Am. Chem. Soc.* **2020**, *142*, 12046–12050.
Empa, Swiss Federal Laboratories for Materials Science and Technology, MPIP, Max Planck Institute for Polymer Research

Coronoids are macrocyclic conjugated hydrocarbons formed by circularly fused benzene rings and bearing a cavity. They can serve as models for graphene with nanoscale cavities, which has intriguing electronic and magnetic properties depending on the size and structure of the pores. The authors report the on-surface synthesis of two new coronoids, [6]coronoid (**C168**) and [5] coronoid (**C140**), featuring unprecedented structures with outer armchair edges and inner zigzag edges. Using scanning probe microscopy techniques and calculations, they were able to thoroughly characterize their structural and electronic properties, revealing a HOMO-LUMO gap of 2.2 and 2.5 eV, respectively, and a very large pore of 1.40 and 1.10 nm, with the latter belonging to a nonplanar frame. This synthetic strategy allows the preparation of coronoids with diverse inner and outer edge structures, and pave the way to obtain larger coronoids with longer inner zig-zag edges, expected to host elusive magnetic states.

Authors' comments:
"This work results from collaborative efforts between Empa and MPIP, bridging the gap between the achievement of synthetically challenging precursors and the on-surface synthesis and characterization – with ultimate resolution – of elusive compounds."
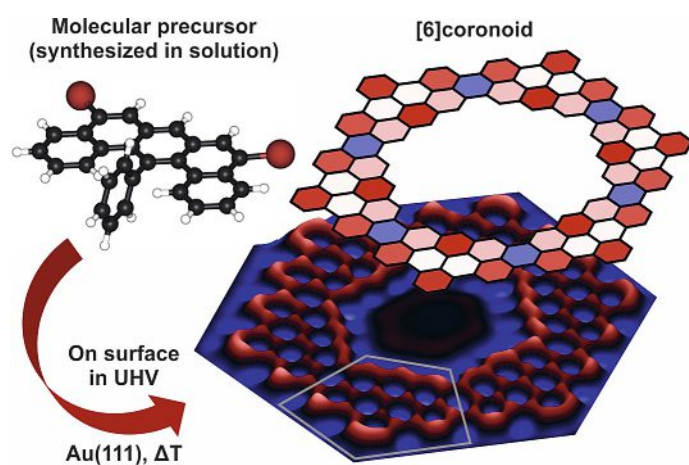
Asymmetric Ni-Catalyzed Radical Relayed Reductive Coupling

X. Wei, W. Shu, A. García-Domínguez, E. Merino, and C. Nevado,* *J. Am. Chem. Soc.* **2020**,142, 13515–13522.
University of Zurich

In recent years, three-component dicarbofunctionalizations of alkenes have been the focus of intense research, and transition metals, in particular Pd and Ni, have played a major role in the development of catalytic versions. Recently, attention has shifted toward catalytic asymmetric alkene dicarbofunctionalizations. In this context, the authors developed an enantioselective intermolecular Ni-catalyzed reductive dicarbofunctionalization of vinyl amides, boranes, and phosphonates with two electrophiles (Csp^2- and Csp^3-halides), proceeding at ambient temperature with excellent regio-and enantioselectivities. An isoleucine-based chiral bisoxazoline ligand and coordinating sites on the alkene to stabilize the Ni center were key to the success of this asymmetric radical relayed reductive coupling (ARRRC). The authors were able to transform the obtained enantioenriched amides into useful chiral building blocks such as primary amines and oxazolines.

Authors' comments:
"Reductive coupling of two electrophiles can be intercepted by alkenes to form consecutive C–C bonds in asymmetric form."