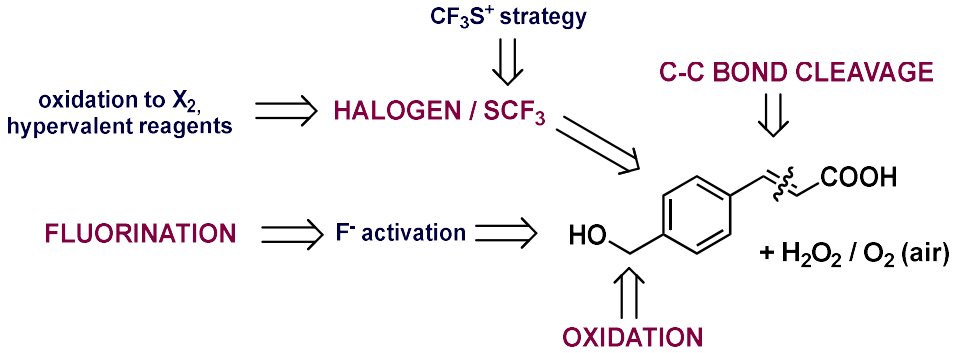
Green Oxidants in Action: Oxidative Halogenation and Functionalization of Organic Molecules and Natural Products using H_2O_2 and O_2

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Oxidation is one of the most fundamental transformations in chemistry. Oxygenated compounds are essential as drugs, materials and building blocks, and nature itself modifies molecules through oxidative pathways, which also inspires our solutions. Classical oxidation methods, however, often rely on toxic or hazardous reagents, heavy metals and chlorinated solvents, and they produce large amounts of waste. Green chemistry asks for a better approach. Hydrogen peroxide and molecular oxygen are the ideal oxidants: they are inexpensive and abundant, and water is their only by-product [1]. Oxidative strategies also enable the incorporation of other functional groups, with halogen atoms being an important example [2].

This lecture explores how H_2O_2 and O_2 can be activated through various strategies, from reaction conditions and solvents to catalysts, and how each mode of activation can be exploited. We will see how the same two oxidants can be used to make peroxides, to oxidize alcohols, to introduce halogens into aromatic compounds and alkenes, with a focus on oxidative halogenation, and to cleave carbon–carbon bonds. Where oxidation alone is not enough, as in fluorination and the introduction of the SCF_3 group, we will combine it with other reagents. The examples range from simple organic molecules to amino acids, peptides, natural products and biomass, and they end with the route from lignin to vanillin.



References

1. N. Jiao, S. S. Stahl (eds.), *Green Oxidation in Organic Chemistry*, Wiley, 2019. E. T. Poursaitis et al. *Chem. Sci.* **2024**, *15*, 1177. Z. Zeng et al. *Chem. Eur. J.* **2026**, *32*, e70865.
2. A. Podgoršek, M. Zupan, J. Iskra, *Angew. Chem. Int. Ed.* **2009**, *48*, 8424–8450. D.-B. Jiang, et al. *Org. Biomol. Chem.* **2023**, *21*, 1571.

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Subject: Short biography of prof. dr. Jernej Iskra

Prof. Jernej Iskra is Professor of Organic Chemistry at the Faculty of Chemistry and Chemical Technology, University of Ljubljana. He received his PhD in organic chemistry from the University of Ljubljana in 1998, working on the fluorination of aromatic molecules under Prof. Marko Zupan. He then joined the Laboratory of Organic and Bioorganic Chemistry at the Jožef Stefan Institute and carried out postdoctoral research as a Marie Curie Individual Fellow at Université Paris-Sud with Prof. Jean-Pierre Bégué on clean oxidation processes in fluorous media. In 2016 he became a professor at the University of Ljubljana, Faculty of Chemistry and Chemical Technology. He is a co-founder of two start-up companies, RGA (Research Genetics and Agrochemistry) and Mediguide (Medical Innovation and Technology).

His research interests include green oxidative methodologies, valorization of lignocellulosic biomass (cellulose, lignin and plant secondary metabolites) and the synthesis of functional nanomaterials based on nanolignin and lignin quantum dots for agricultural applications.

Prof. Iskra is the author of 85 peer-reviewed papers, 12 books and book chapters, and a co-inventor of 4 patents, with over 3,000 citations. He has supervised 8 PhD, 19 MSc and 40 BSc students. His work has been recognized with the University of Ljubljana Rector's Award (2010, 2012, 2024) and the national Excellence in Science Award (2013, 2022). He serves on the Committee for Socio-economic Analysis (SEAC) of the European Chemicals Agency and chairs the Committee for Awards and Promotion at the Faculty of Chemistry and Chemical Technology, University of Ljubljana.

Curriculum Vitae
prof. dr. Jernej Iskra

Education:

1993-1998: PhD studies (organic chemistry), Faculty of Chemistry and Chemical Technology, University of Ljubljana, "The effect of reagent structure on fluorination of aromatic molecules", supervisor: prof. dr. Marko Zupan.

1989-1993: B. Sc. studies in chemistry, Faculty of Chemistry and Chemical Technology, University of Ljubljana

Academic title and scientific-research degree:

2022-: Professor in organic chemistry, Faculty of Chemistry and Chemical Technology, University of Ljubljana.

2016-: Associate Professor in organic chemistry, Faculty of Chemistry and Chemical Technology, University of Ljubljana.

2016-: Associate Professor in organic chemistry, Faculty of Chemistry and Chemical Technology, University of Maribor.

2015-: Associate Professor in organic chemistry, Jožef Stefan International Postgraduate School.

2009-: Senior Research Associate, Jožef Stefan Institute.

2003-2009: Research Associate, Jožef Stefan Institute.

Positions held:

2016-: professor of organic chemistry, Faculty of Chemistry and Chemical Technology, University of Ljubljana.

2025-: co-founder of spinoff Mediguide – Medical Innovation & Technology,

2014-: co-founder and CEO of spinoff RGA – research genetics and agrochemistry

1999-2016: Jožef Stefan Institute (Senior Research Associate).

2011-2016: Faculty of Chemistry and Chemical Technology, University of Maribor (professor, additional employment, part time).

2010-2014: Centre of Excellence for Integrated Approaches in Chemistry and Biology of Proteins (Senior Research Associate, part time).

2000-2002: postdoctoral position (Marie Curie Individual Fellowship at BioCIS, Universite Paris-Sud, France: "Clean oxidation processes in fluorous media"; supervisor: Jean-Pierre Bégué).

1994-1998: young researcher, Faculty of Chemistry and Chemical Technology, University of Ljubljana.

Awards

2024: **Rector award for best innovation** of University of Ljubljana (winner, Mediguide; Griša Prinčič, Jernej Iskra, Dime Stefanovski in Matej Klepec).

2024: **The EIT Jumpstarter Grand Final 2024**, finalist, Mediguide.

2022: **Excellence in Science 2022** – Chemistry (Oxidative cleavage of C–C double bond with hydrogen peroxide for valorization of natural molecules, Slovenian Research Agency).

2021: **Slovenian Agro Hi-tech competition 2021**, **The best idea**, (Jernej Iskra and Primož Titan with RGA, ltd.)

2015: **Start:up Slovenia 2015** (semifinal 3rd place, RGA: Wheat "De novo" or how to improve degeneration, Primož Titan and Jernej Iskra).

2014: **Excellence in Science 2013** – Chemistry (In situ formation of iodine(I) reagent in oxidative iodination of aromatic molecules with hydrogen peroxide and iodine catalyzed by hydrochloric acid, Slovenian Research Agency).

2014: **Silver award of Chamber of Commerce** of Dolenjska in Bela krajina (Inventive process for production of active ingredient and its incorporation into pharmaceutical product for treatment of infection in animals, Jernej Iskra and Krka, d.d.).

2013: **Innovation with best commercial potential from Public Research Organizations** (National Innovation Day, Chamber of Commerce of Republic of Slovenia, 1st award: Corrosion protection with hybrid sol-gel coating - "TMZ coating - The most resent approach of protection", Jernej Iskra, Barbara Kapun, Ingrid Milošev and Peter Rodič)

2012: **Rector award for best inovation** of University of Ljubljana (3rd place, Hybrid sol-gel coatings for corrosion protection of alluminium and its alloys; Jernej Iskra, Barbara Kapun, Ingrid Milošev, Peter Rodič).

2010: **Rector award for best innovation** of University of Ljubljana (finalist, Chemical hybridization for exploitation of heterosis in common wheat (Triticum aestivum L.), Primož Titan, Vladimir Meglič, Miloš Fišakov and Jernej Iskra).

2008: **Silver award of Chamber of Commerce** of Dolenjska in Bela krajina (Process of preparation of 2-sulfinyl-1H-benzimidazoles, Berta Kotar Jordan, Jernej Iskra, Miloš Ružič, Rok Zupet, Janez Smodiš and Stojan Stavber).