

# **(Photo)Catalytic Metal Complexes for Lipid Peroxidation–Driven Anticancer Therapy**

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**CICLO CONFERENCIAS ISQCH 2026**

# (Photo)Catalytic Metal Complexes for Lipid Peroxidation–Driven Anticancer Therapy

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Metal complexes possess unique chemical properties, such as redox activity, catalytic function, diverse coordination geometries, and rich photophysics, that make them attractive for therapeutic development. These features enable anticancer strategies with mechanisms distinct from conventional small molecules. One promising route is the induction of ferroptosis, a lipid peroxidation–driven form of cell death that can overcome apoptosis resistance and limitations of hypoxic tumors. Here, we present two complementary projects that use transition-metal catalysis to trigger ferroptosis in cancer cells. The first project describes a cobalt(III) polypyridine sulfasalazine complex acting as an intracellular redox catalyst. After uptake, it accumulates in mitochondria, where the cobalt center generates hydroxyl radicals. This activity enhances oxidative stress, drives lipid peroxidation, and induces ferroptosis. The compound is effective in both 2D cancer cell cultures and 3D colon carcinoma spheroids and represents the first cobalt complex reported to induce ferroptosis.[1] The second project introduces a heterobifunctional ruthenium–iron photocatalyst combining a ruthenium polypyridine photosensitizer with an iron-chelating deferasirox unit. It operates by two light-driven pathways: generating singlet oxygen under normoxia and producing hydroxyl radicals by intramolecular electron transfer under hypoxia. This dual mechanism ensures activity in oxygen-poor tumors where traditional photodynamic therapy is limited. Mechanistic studies show mitochondrial disruption, membrane depolarization, antioxidant depletion, GPX4 inactivation, and extensive lipid peroxidation, leading to ferroptotic death and elimination of drug-resistant cells.[2] Together, these studies highlight cobalt redox catalysis and ruthenium–iron photocatalysis as effective strategies to induce ferroptosis and advance next-generation anticancer therapies.

## References:

[1] N. Montesdeoca, L. Johannknecht, E. Efanova, J. Heinen-Weiler, J. Karges\*, Ferroptosis Inducing Co(III) Polypyridine Sulfasalazine Complex for Therapeutically Enhanced Anticancer Therapy, *Angew. Chem. Int. Ed.* **2024**, *63*, e202412585.

[2] N. Montesdeoca, Z. Papadopoulos, H. M. Tran, S. Krause Hinojosa, H. Sielhorst, J. Heinen-Weiler, J. Karges\*, Exploiting Metal-to-Metal Electron Transfer in a Ru(II) Polypyridine–Deferasirox Conjugate for Hypoxic Photodynamic Therapy, *J. Am. Chem. Soc.* **2026**, *148*, 15640-15654.

# Johannes Karges

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## PROFESSIONAL POSITIONS

- 2026 - present      **W3 Full Professor in Biophysics**  
Faculty of Medicine, Ruhr University Bochum, Germany
- 2025 - 2026        **W1 Junior Professor in Inorganic Biochemistry**  
Faculty of Chemistry and Biochemistry, Ruhr University Bochum,  
Germany
- 2022 - 2025        **Liebig Fellow Junior Group Leader of the Funds of the German  
Chemical Industry**  
Faculty of Chemistry and Biochemistry, Ruhr University Bochum,  
Germany
- 2024                **Visiting Guest Professor**  
University of Vienna, Austria
- 2020 - 2022        **Post-Doctoral Research Fellow**  
University of California, San Diego (UCSD), La Jolla, USA  
Topic: Design, Synthesis and Biological Evaluation of Metal Complexes  
as Enzyme Inhibitors  
Advisor: Prof. Seth M. Cohen

## EDUCATION

- 2016 - 2020        **PhD Student in Medicinal Chemistry**  
École Nationale Supérieure de Chimie de Paris (ENSCP) - Université  
Paris Sciences et Lettres (PSL), Paris, France  
Topic: Design, Synthesis, Characterization and Biological Evaluation of  
Metal Complexes for One- and Two-Photon Photodynamic Therapy  
Advisor: Prof. Gilles Gasser
- Exchange at Sun Yat-Sen University, Guangzhou, China  
Advisor: Prof. Hui Chao

- 2015 - 2016 **Master of Science in Chemistry**  
Philipps-University, Marburg, Germany  
Grade: 1.0 (1.0 – 6.0)
- 2014 - 2015 Imperial College, London, United Kingdom  
Erasmus Exchange during Master of Science degree
- 2011 - 2014 **Bachelor of Science in Chemistry**  
Philipps-University, Marburg, Germany  
Grade: 1.8 (1.0 – 6.0)

## AWARDS

- 2024 **Paul Ehrlich & Ludwig Darmstaedter Early Career Award** for Excellence in Biological and Medicinal Research by the Paul-Ehrlich Foundation
- 2024 **Dr. Otto Röhm Gedächtnisstiftung Award** for Excellence in Chemical Research for Junior Faculty in Germany by Dr. Otto Röhm Gedächtnisstiftung Foundation
- 2023 Inclusion in the Journal ChemBioChem's **Emerging Leaders list as a "ChemBioTalent 2022/23"**
- 2023 **Life Sciences Bridge Award** for Excellence in Interdisciplinary Science and Research by the Aventis Foundation
- 2023 **Breast Cancer Research Junior Award** for Excellence in the Development of Therapeutic Agents against Breast Cancer by the Claudia von Schilling Foundation
- 2022 **Liebig Fellowship** for the Establishment of a Junior Research Group by the Funds of the German Chemical Industry (FCI)
- 2022 **Leadership Development Award** of the Younger Chemists Committee of the American Chemical Society (ACS)
- 2022 Inclusion in the Journal of Coordination Chemistry list as one of **Emerging Leaders of Coordination Chemistry**
- 2022 **Cultural Awareness and Sustainability Award** for Communication, Collaboration, Cultural Awareness, Creativity, and Project Management Skills based on the UN Sustainable Development Goals by the American Chemical Society (ACS)
- 2022 **Nomination for Participation and Travel Grant for the Postdoc to Faculty (P2F) Workshop** of the American Chemical Society (ACS)
- 2021 **Wilhelm Ostwald Young Investigator Award** for Excellence in Interdisciplinary Science and Research by the German Chemical Society (GDCh), Wilhelm-Ostwald-Society (WOG), and the German Bunsen Society (DBG)
- 2021 **Travel Award** for participation at the University of California Drug Discovery Consortium (UCDDC) 4<sup>th</sup> Annual Symposium, Irvine, California, USA
- 2021 **Flash Presentation Award** from the Society of Biological Inorganic

	Chemistry for the Best Presentation at the Electronic Biological Inorganic Chemistry Meeting (eBIC)
2021	<b>Nomination for Participation and Travel Grant for the Lasting Encounters between Aspiring and Distinguished Scientists (LEADS) Conference</b> of the American Chemical Society (ACS)
2021	<b>University of California Chemical Symposium (UCCS) Platform Talk Award</b> for the Best Presentation
2020	<b>René Dabard – ENSCR Award</b> for the best PhD Thesis in Chemistry in France
2020	<b>Reaxys PhD Prize</b> Finalist of the world's most Prestigious Award for PhD Students for Excellence in Science and Research
2020	<b>Ethical Challenges of Research</b> for Endeavors in Research Ethics by University of California, San Diego
2015	<b>Deutschlandstipendium Scholarship</b> by Philipps-University Marburg and Clariant Deutschland GmbH for Excellence during Master of Science Studies
2014	<b>Erasmus Scholarship</b> for a stay at Imperial College, London, United Kingdom
2009	<b>Youth Group Leader Award</b> (Juleica) for Excellence in Organization and Leadership of Youth Groups

## SCIENTIFIC CONTRIBUTIONS

### Publication Statistics:

117 peer-reviewed papers, 6 book chapters, h-index: 40, i10-index: 86, overall citations > 6200.

### 5 Recent Key Publications

[1] N. Montesdeoca, Z. Papadopoulos, H. M. Tran, S. Krause Hinojosa, H. Sielhorst, J. Heinen-Weiler, **J. Karges\***, Exploiting Metal-to-Metal Electron Transfer in a Ru(II) Polypyridine–Deferasirox Conjugate for Hypoxic Photodynamic Therapy, *J. Am. Chem. Soc.* **2026**, *148*, 15640-15654

[2] R. Zimmermann, N. Montesdeoca, **J. Karges\***, Light Activated Induction of Cuproptosis in Resistant Cancer Cells Using Polymeric BODIPY Nanoparticles for Photoactivated Chemotherapy, *Adv. Funct. Mater.* **2026**, e31605.

[3] H. Zhang, N. Montesdeoca, D. Tang, G. Liang, M. Cui, C. Xu, L.-M. Servos, T. Bing, Z. Papadopoulos, M. Shen, H. Xiao\*, Y. Yu\*, **J. Karges\***, Tumor-Targeted Glutathione Oxidation Catalysis with Ruthenium Nanoreactors against Hypoxic Osteosarcoma, *Nature Commun.* **2024**, *15*, 9405.

[4] N. Montesdeoca, L. Johannknecht, E. Efanova, J. Heinen-Weiler, **J. Karges\***, Ferroptosis Inducing Co(III) Polypyridine Sulfasalazine Complex for Therapeutically Enhanced Anticancer Therapy, *Angew. Chem. Int. Ed.* **2024**, *63*, e202412585.

[5] H. Zhou, D. Tang, Y. Yu, L. Zhang, B. Wang, **J. Karges\***, H. Xiao\*, Theranostic Imaging and Multimodal Photodynamic Therapy and Immunotherapy using the mTOR Signaling Pathway, *Nature Commun.* **2023**, *14*, 5350.