



# Frontier Actinide Radiation Chemistry

June 2022

*Changing the World's Energy Future*

Gregory P Horne, Stephen P. Mezyk, Travis S Grimes, Andrew R. Cook,  
Thomas E. Albrecht-Schnzart



*INL is a U.S. Department of Energy National Laboratory operated by Battelle Energy Alliance, LLC*

#### **DISCLAIMER**

This information was prepared as an account of work sponsored by an agency of the U.S. Government. Neither the U.S. Government nor any agency thereof, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness, of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. References herein to any specific commercial product, process, or service by trade name, trade mark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the U.S. Government or any agency thereof.

# **Frontier Actinide Radiation Chemistry**

**Gregory P Horne, Stephen P. Mezyk, Travis S Grimes, Andrew R. Cook, Thomas  
E. Albrecht-Schnzart**

**June 2022**

**Idaho National Laboratory  
Idaho Falls, Idaho 83415**

**<http://www.inl.gov>**

**Prepared for the  
U.S. Department of Energy  
Under DOE Idaho Operations Office  
Contract DE-AC07-05ID14517**



# Frontier Actinide Radiation Chemistry



Gregory P. Horne<sup>1\*</sup>, Stephen P. Mezyk<sup>2</sup>, Travis S. Grimes<sup>1</sup>, Andrew R. Cook<sup>3</sup>, and Thomas E. Albrecht-Schönzart<sup>4</sup>

<sup>1</sup> Center for Radiation Chemistry Research, Idaho National Laboratory, Idaho Falls, ID, P.O. Box 1625, 83415, USA.

<sup>2</sup> Department of Chemistry and Biochemistry, California State University Long Beach, 1250 Bellflower Boulevard, Long Beach California, 90840-9507, USA.

<sup>3</sup> Department of Chemistry, Brookhaven National Laboratory, Upton, New York, 11973, USA.

<sup>4</sup> Department of Chemistry and Biochemistry, Florida State University, Tallahassee, FL 32306, USA.

\* Gregory.Horne@inl.gov

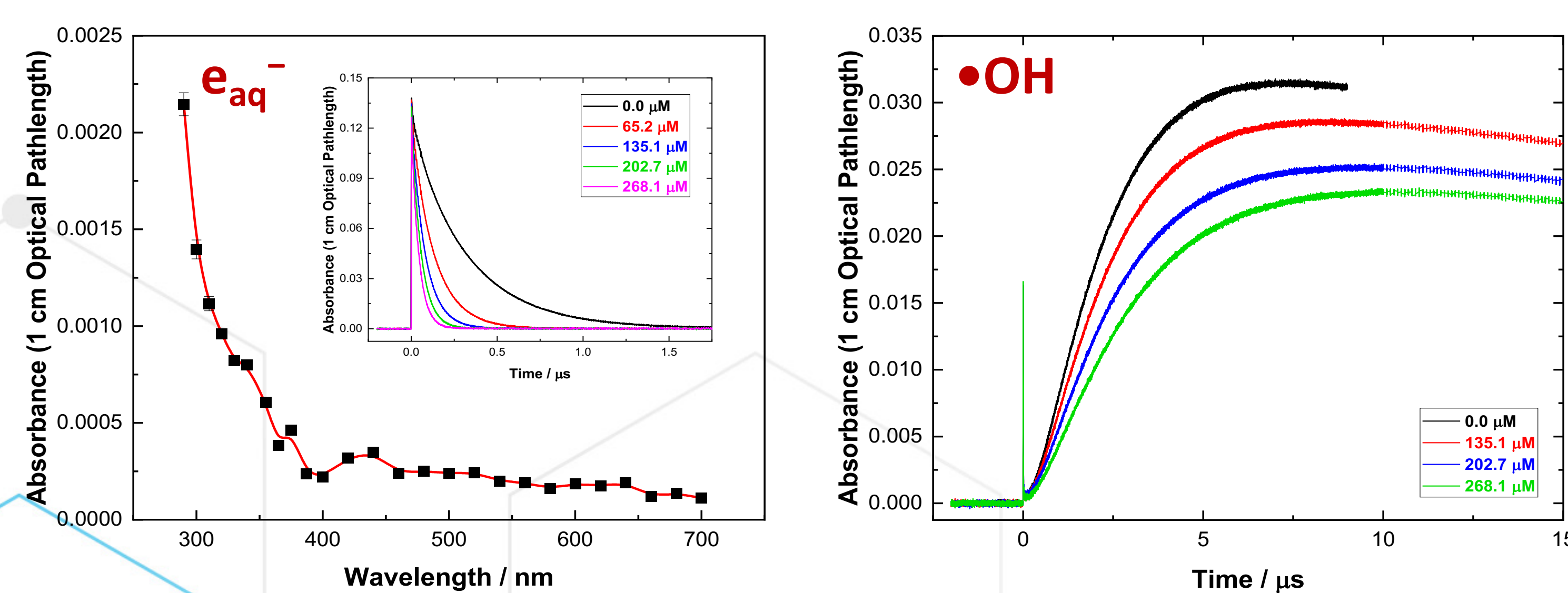
## Radiation-Induced Redox Chemistry

- The actinide series marks the point in the periodic table where nuclear instability and the effects of relativity define the basic characteristics of these elements.
- Despite the inherency and significant impact of radiation-induced redox reactions, fundamental knowledge of actinide radiation chemistry is limited.
- The presented time-resolved electron pulse radiolysis data highlight the existence of rich, complex, intrinsic actinide radiation chemistry with redox-active species from the radiolysis of water ( $e_{aq}^-$  and  $\bullet OH$ ) and *n*-dodecane ( $RH^{\bullet+}$ ).



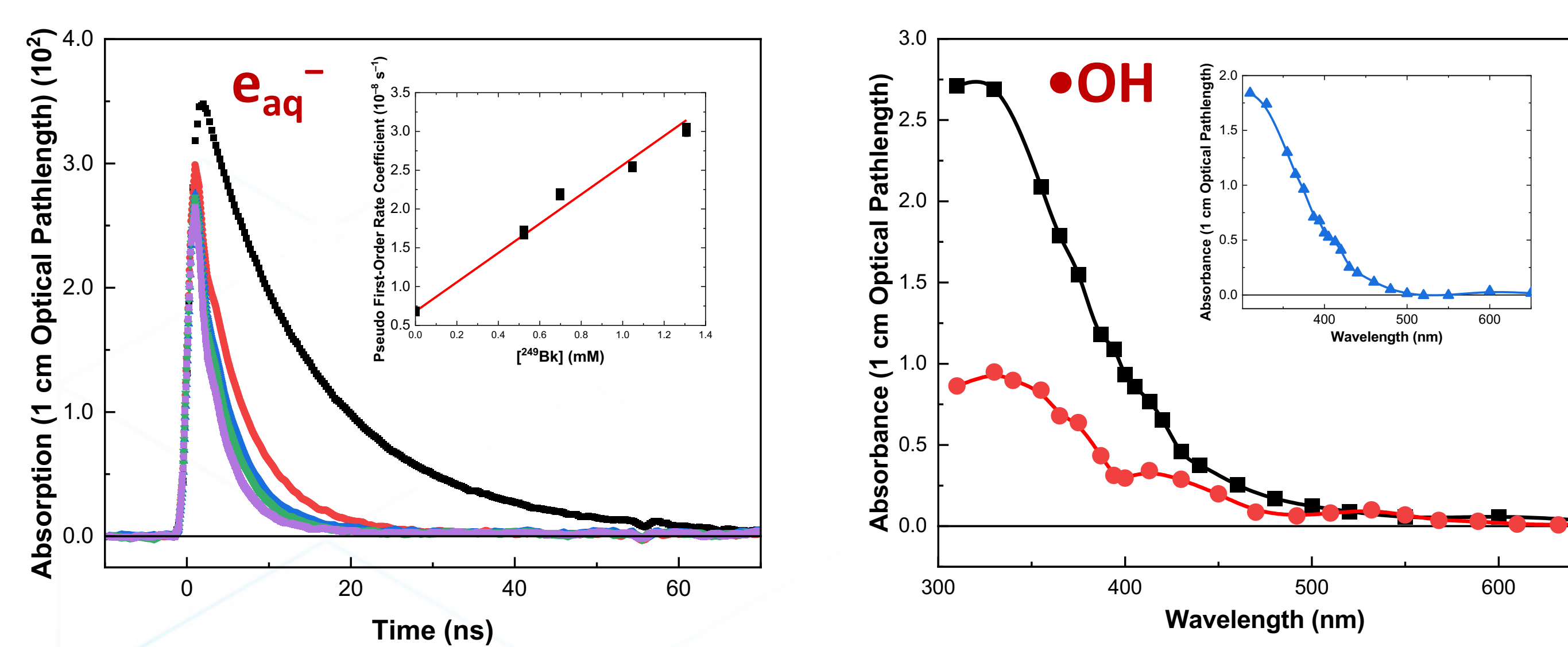
## Curium-248

Horne, Grimes, Zalupski, Meeker, Albrecht-Schönzart, Cook, and Mezyk, *Dalton Transactions*, **2021**, 50, 10853.



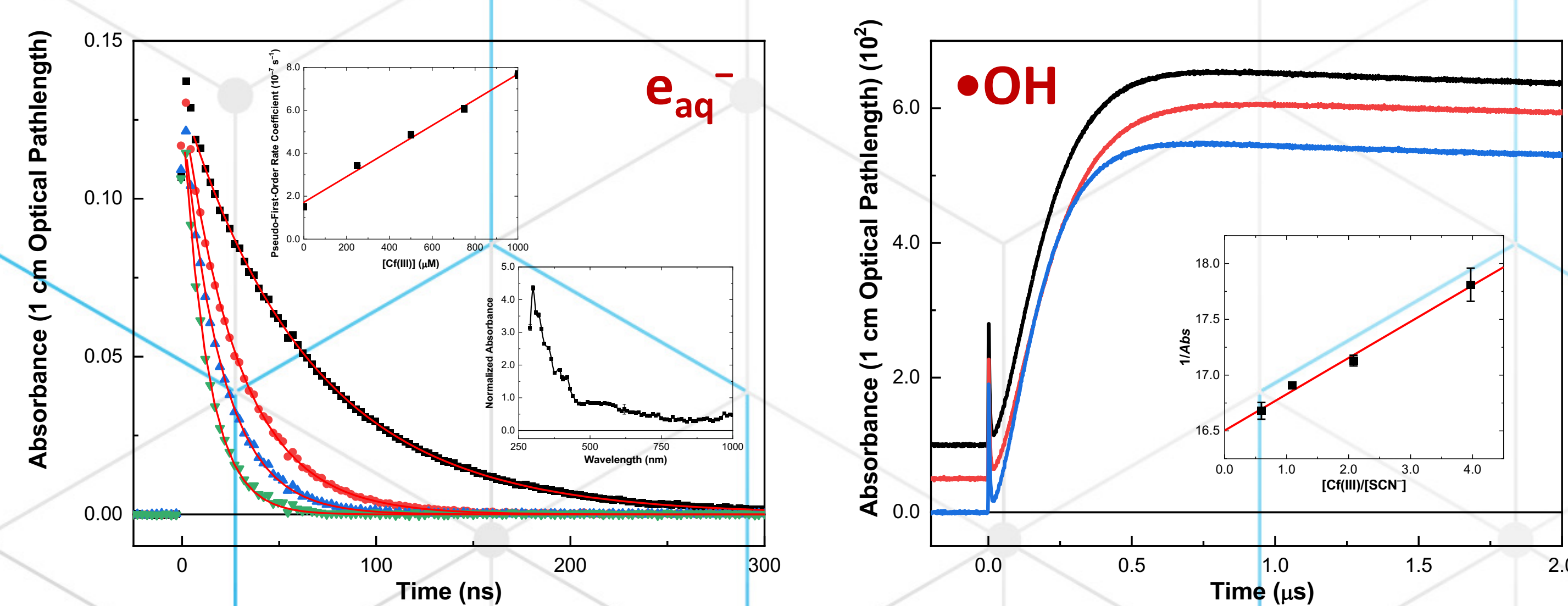
## Berkelium-249

Horne, Rotermund, Grimes, Sperling, Meeker, Zalupski, Beck, Gomez Martinez, Beshay, Peterman, Layne, Cook, Albrecht-Schönzart, and Mezyk, *Inorganic Chemistry*, **2022**, in peer review.



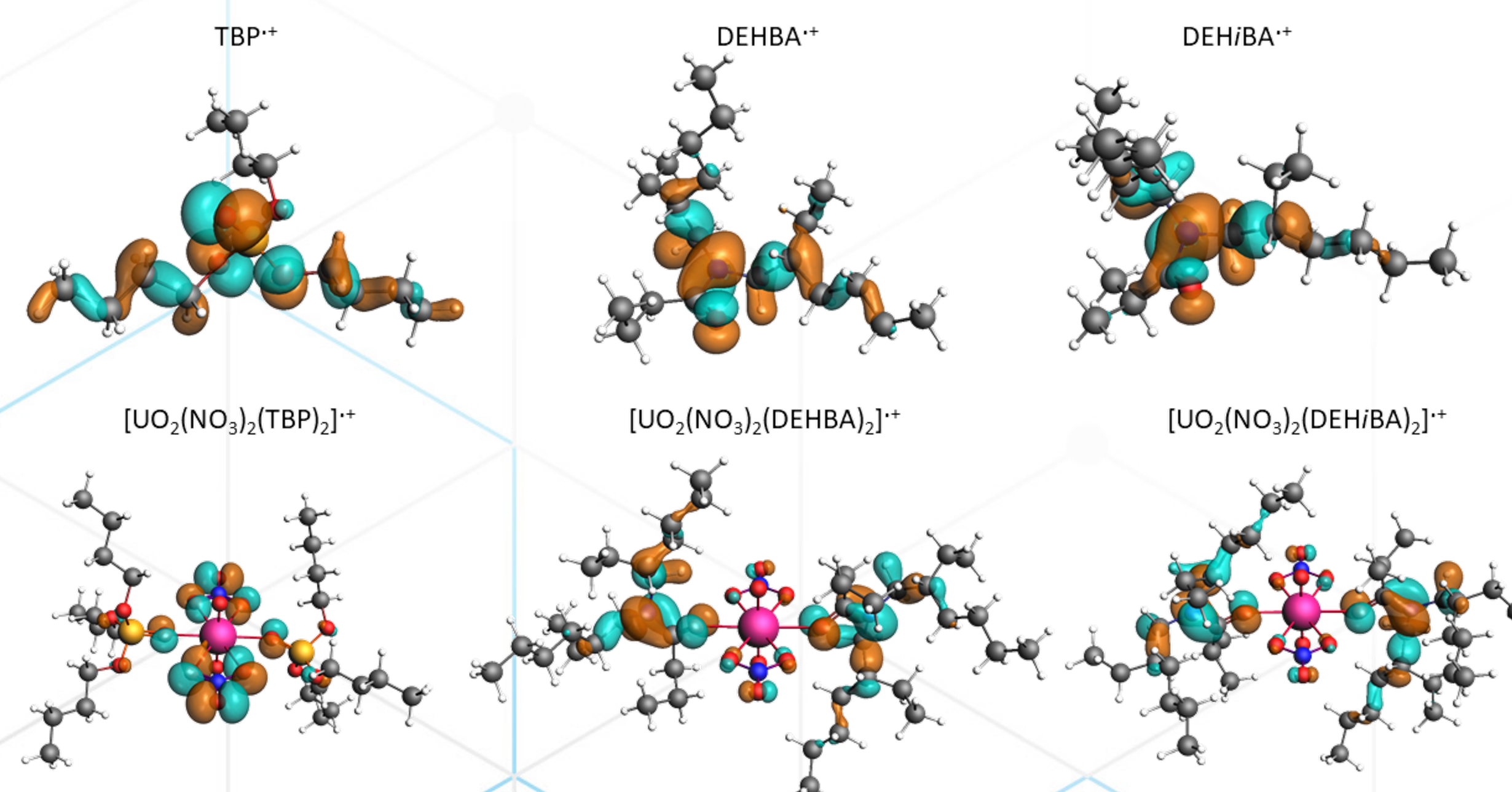
## Californium-249

Horne, Rotermund, Grimes, Sperling, Meeker, Zalupski, Beck, Gomez Martinez, Beshay, Peterman, Layne, Cook, Albrecht-Schönzart, and Mezyk, *Inorganic Chemistry*, **2022**, in peer review.



## Effects of Uranyl Complexation

Celis-Barros, Pilgrim, Cook, Grimes, Mezyk, and Horne, *Physical Chemistry Chemical Physics*, **2021**, 23, 24589.



**Acknowledgements:** This work was supported by the U.S. Department of Energy (DOE), Office of Science, Office of Basic Energy Sciences, under Award DE-SC0021372, and the U.S. DOE Assistant Secretary for Nuclear Energy, under the Material Recovery and Waste Form Development Campaign, DOE-Idaho Operations Office Contract DE-AC07-05ID14517. Mezyk was supported by the Nuclear Energy Universities Program (NEUP) under grants DE-NE0008406 and DE-NE0008659. The efforts of Cook and pulsed electron irradiation experiments at the Laser-Electron Accelerator Facility (LEAF) of the Brookhaven National Laboratory Accelerator Center for Energy Research were supported by the U.S. DOE Office of Basic Energy Sciences, Division of Chemical Sciences, Geosciences, and Biosciences under contract DE-SC0012704.