



# Moderate High Pressure X-ray Radiation-Induced Degradation of Persistent Poly- and Perfluoroalkyl Substances (PFAS)

August 2024

*Changing the World's Energy Future*

Gregory Peter Holmbeck, Egor Evlyukhin, Michael G. Pravica



*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.

# **Moderate High Pressure X-ray Radiation-Induced Degradation of Persistent Poly- and Perfluoroalkyl Substances (PFAS)**

**Gregory Peter Holmbeck, Egor Evlyukhin, Michael G. Pravica**

**August 2024**

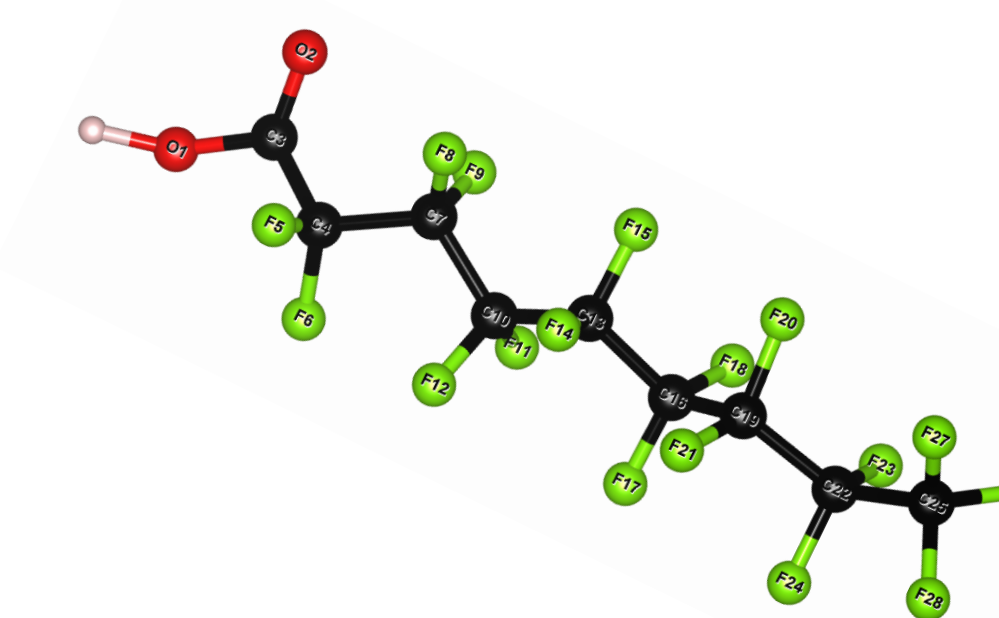
**Idaho National Laboratory  
Idaho Falls, Idaho 83415**

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

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



# Moderate High Pressure X-ray Radiation-Induced Degradation of Persistent Poly- and Perfluoroalkyl Substances (PFAS)



UNLV

Gregory P. Holmbeck<sup>1</sup>, Egor Evlyukhin<sup>2</sup>, and Michael G. Pravica<sup>2</sup>

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

<sup>2</sup> Department of Physics and Astronomy, University of Nevada Las Vegas (UNLV), Las Vegas, NV, U89154-4002, USA.

## Motivation

- PFAS are extremely chemically resistant compounds, leading to their accumulation and persistence in the environment.
- PFAS have been linked to physiological problems, including infertility and cancer, resulting in a national initiative to effectively destroy them.
- Current PFAS remediation technologies have not been effective. This project investigated the proof-of-concept of coupling high pressure ( $\leq 30$  GPa) with ionizing radiation fields to enhance PFAS destruction.

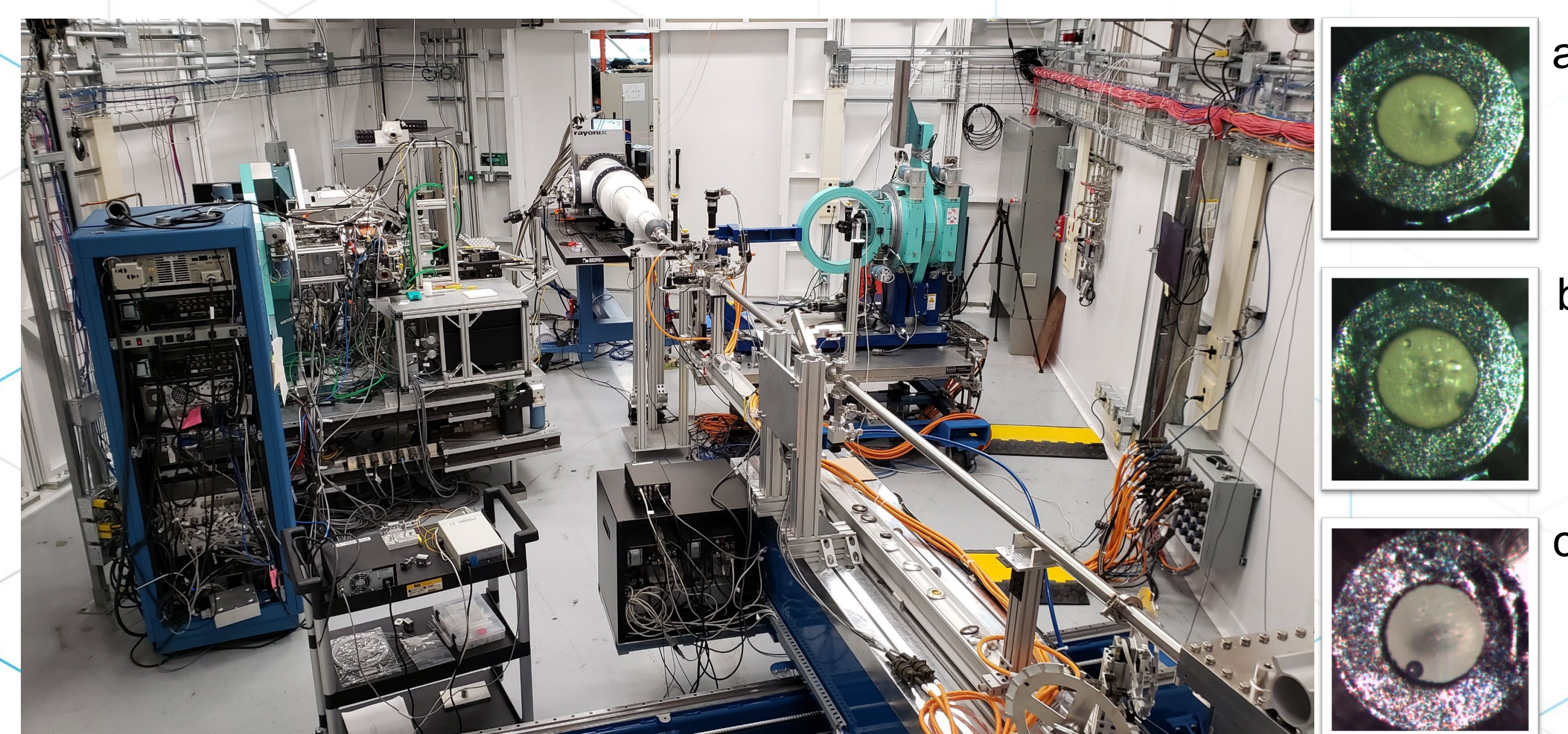


Fig. 1. Canadian Light Source (CLS) Brockhouse Diffraction Sector and Far Infra-red beamlines. Inset: Solid PFOA sample pressurized to 2 GPa (a), irradiated for 1 hr with white X-rays, and decompressed to ambient pressure (b), and finally opened revealing a liquid PFAS mixture (c).

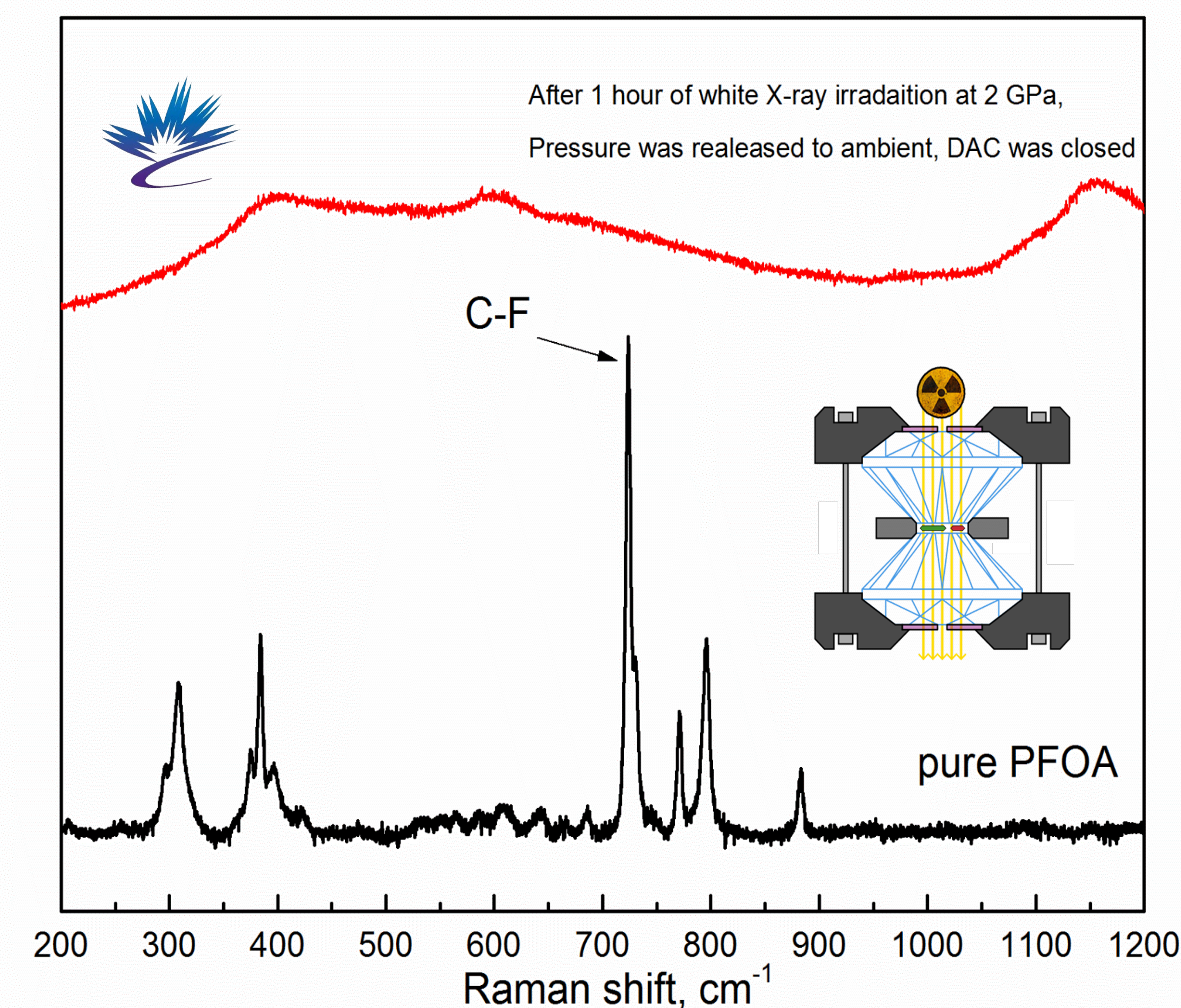


Fig. 2. Raman spectra (532 nm) of PFOA pressurized to 2 GPa in a Diamond Anvil Cell (DAC) before (black) and after CLS synchrotron x-ray irradiation (red) demonstrating radiation-induced molecular breakdown of perfluorooctanoic acid.

## Conclusions

- High pressure in combination with x-ray irradiation afforded PFAS decomposition. Our proposed approach may be a viable method to break these "forever chemicals" down into their constituents.

Project Number: 23P1079-010FP

LRS Number: INL/MIS-24-80041

www.inl.gov

Work supported through the INL Laboratory Directed Research & Development (LDRD) Program under DOE Idaho Operations Office Contract DE-AC07-05ID14517."

Battelle Energy Alliance manages INL for the U.S. Department of Energy's Office of Nuclear Energy

INL Idaho National Laboratory