INL/MIS-21-64666-Revision-0

VHTR Fuel and Fuel Cycle Project Management Board Status Update

October 2021

Paul A Demkowicz

Changing the World's Energy Future

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

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Paul Demkowicz, Ph.D.
Idaho National Laboratory

VHTR SSC Meeting
5 October 2021

17th Official Meeting of the FFC PMB

- Virtual event held on 14-15 Sep 2021
- Canada participated as an observer

Korea
- Eung Seon Kim

France
- Thierry Lambert (*observer*)

China
- Bing Liu

Japan
- Jun Aihara

EU
- Waclaw Gudowski

USA
- Paul Demkowicz
- John Hunn
- Tyler Gerczak (*observer*)

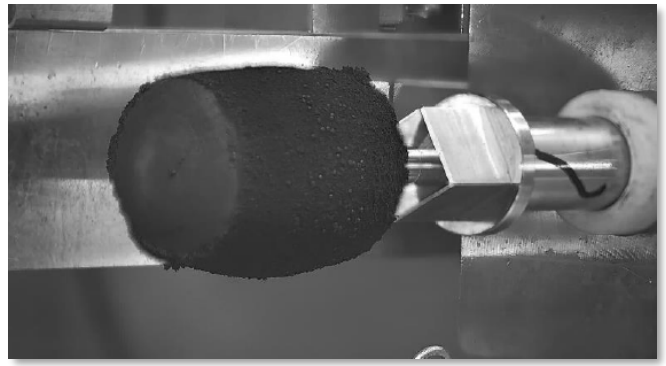
Tech. Secretary
- Gabriele Grassi

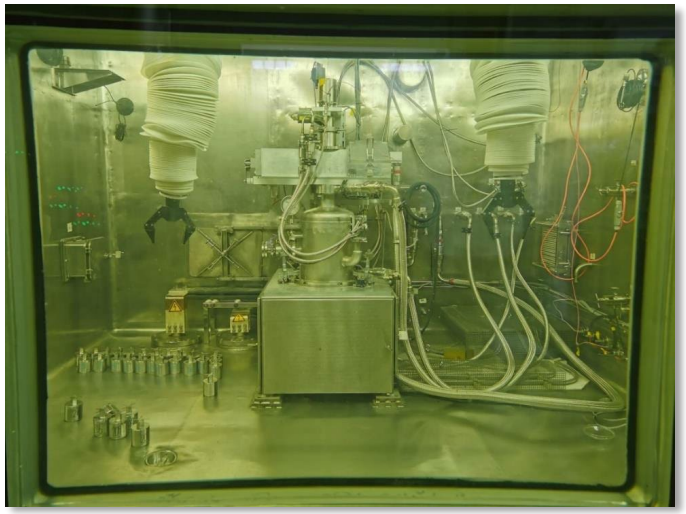
UK
- Tim Abram (*observer*)

Canada
- Ali Siddiqui (observer)

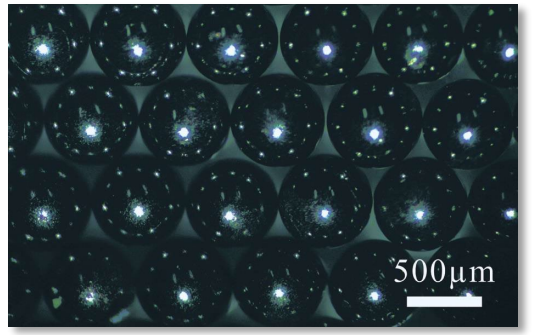
China

- Continuing with plans to perform post-irradiation heating tests and destructive examination on INET pebbles from the HFR-EU1 test
  - One pebble previously tested in KÜFA at JRC Karlsruhe
  - Heating test of second pebble delayed by hot cell maintenance and COVID
- PIE of HTR-10 pebbles at new INET hot cells continues
  - Burnup measurement
  - Pebble deconsolidation
- Hot testing of INET KÜFA has been delayed by COVID, but planned for next year



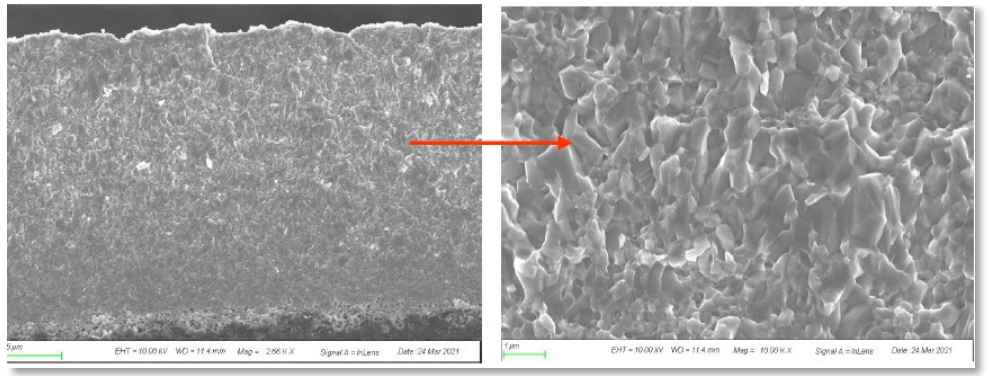


China



Advanced TRISO Fuel Process Development:

- UCO kernel fabrication development; studies underway to examine microstructure and improve kernel quality
- ZrC coating fabrication development



HTR-PM Fuel:

- ~850,000 fuel pebbles fabricated
- First fuel loading (4.2% 235U) fabrication completed
- Development of new manufacturing line with larger capacity is in progress

Japan

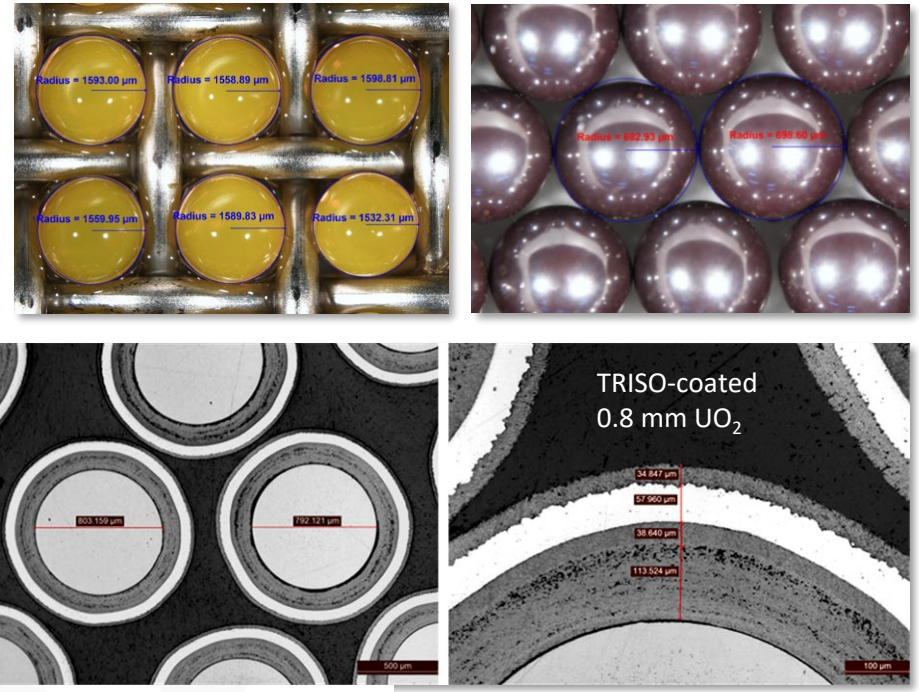
- HTTR restarted operation on July 30, 2021
- JAEA has a plan to conduct various tests to confirm safety, core physics & thermal-fluid characteristics, and fuel performance
- Benchmark proposed by JAEA to model short- to middle-lived fission product (fission gases, iodine) release behaviors under normal and accident conditions has been withdrawn
- Activity to evaluate oxidation behavior of SiC via experiment and modeling has been postponed without funding

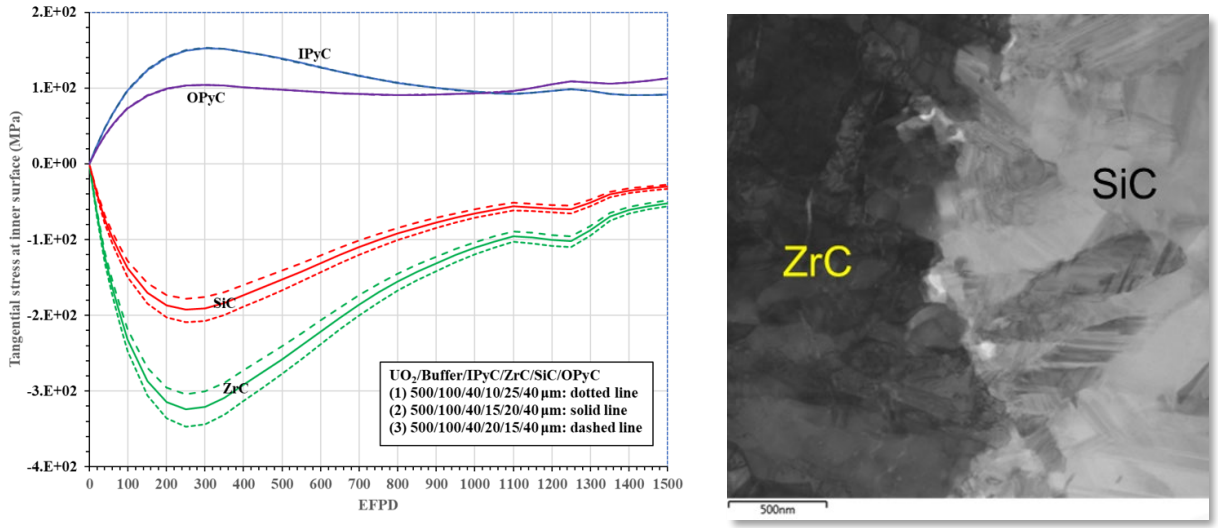
EU

- “Research HTGR at NCJB” project has started
  - Research reactor conceptual design
  - Dialogue with regulator
  - Materials studies, including TRISO fuel
- ~100g of NUKEM TRISO fuel to be transferred to NCJB
  - As-fabricated fuel characterization
  - Maria reactor irradiation is planned
- TRISO lab is under construction

Korea

- Studies on fabrication of large (~800 μm) UO_2 kernels
- FB-CVD coating process development for large UO_2 kernels
- Development of advanced coating design incorporating a ZrC-SiC composite structure intended to extend fuel life in a VHTR
  - Computational studies
  - Experimental studies of ZrC-SiC bilayers, including proton irradiation experiments





Designs of ZrC-SiC double layers in a coated fuel particle

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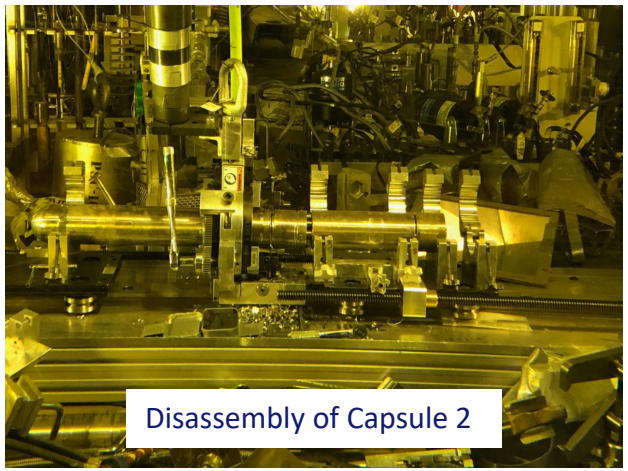
US

- **AGR-2 PIE and accident safety testing completed**
  - Destructive examination on 14 fuel compacts
  - 16 high-temperature safety tests
  - Thousands of particles gamma counted and examined in cross section

- **AGR-5/6/7 irradiation complete**
  - Irradiation completed July 2020
  - 194 fuel compacts
  - 15.3% FIMA; peak temperature ~1500°C
  - PIE began Spring 2021


Disassembly of Capsule 2

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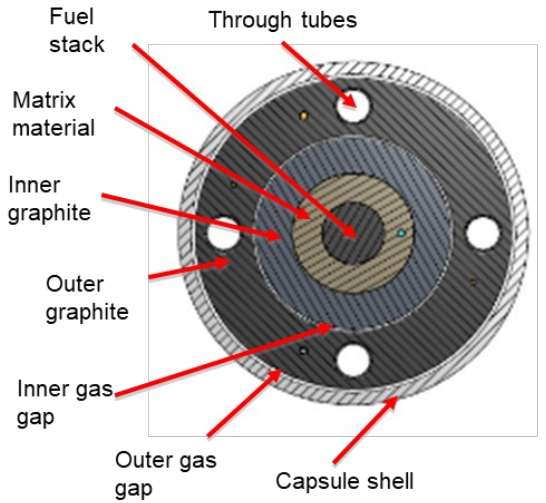
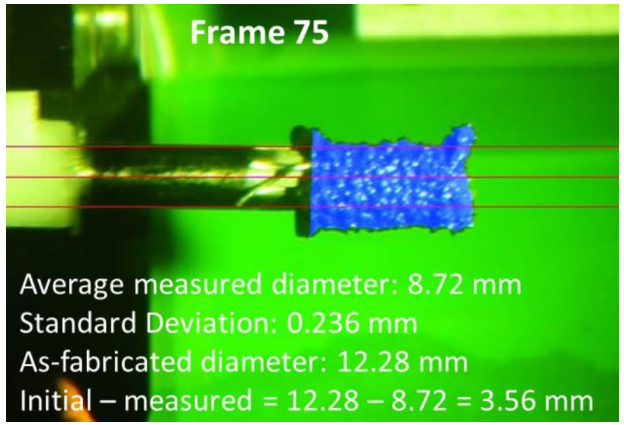
US

- **AGR-3/4 PIE and heating tests in progress**
  - Assess fission product transport in fuel and core graphite materials

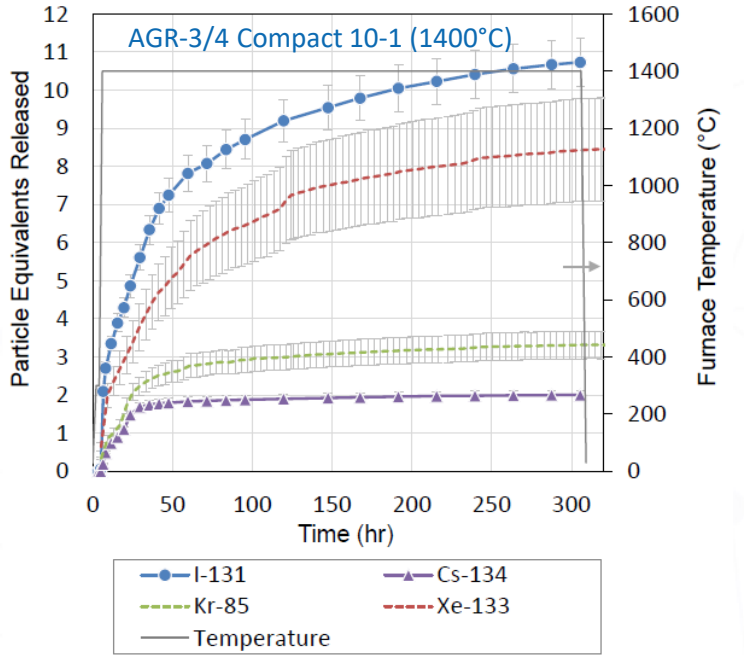


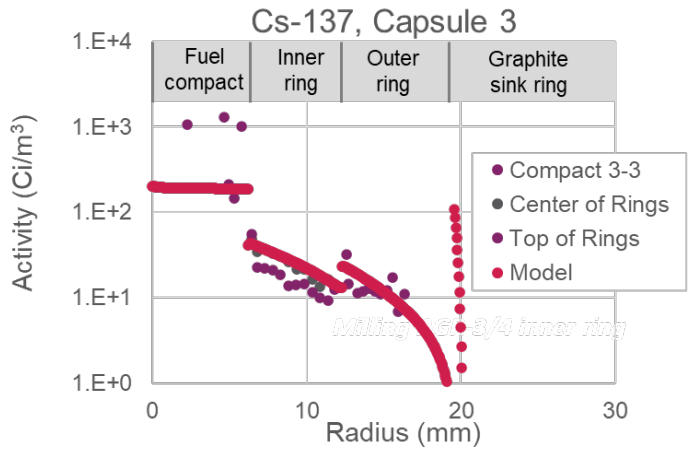
AGR-3/4 Capsule Cross Section

AGR-3/4 fuel compact after several deconsolidation steps, leaving only the core



Fission product release during heating of re-irradiated fuel compact to assess short-lived fission product behavior



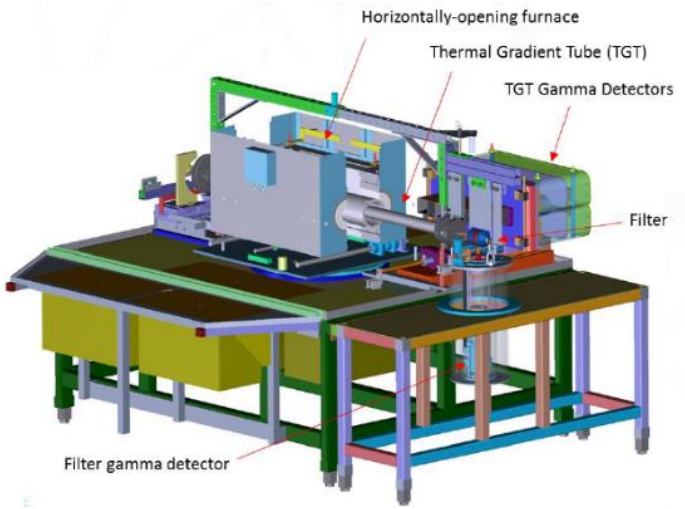


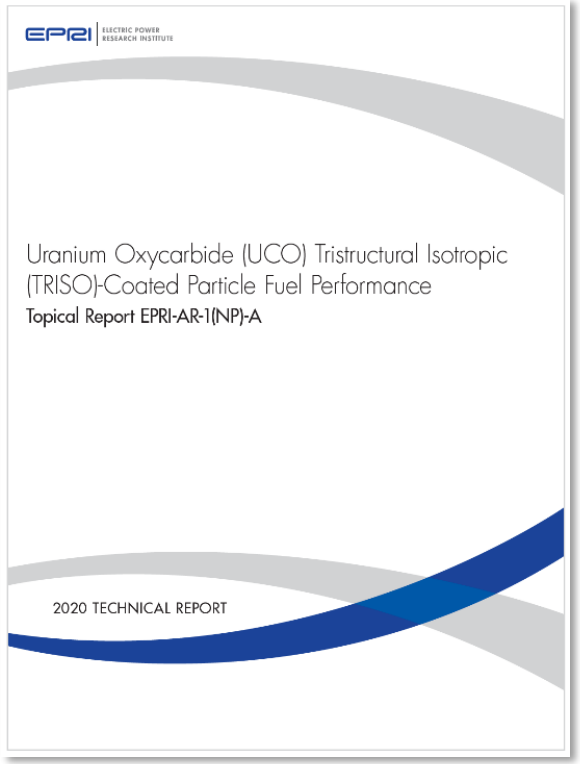
Measured and calculated ^{137}Cs profile in fuel and surrounding materials after irradiation

US

- **Develop furnace system for air/steam tests on irradiated fuel**
  - Expected deployment in early 2023

- **Licensing topical report on UCO TRISO fuel performance**
  - EPRI UCO TRISO Topical Report was submitted to the NRC in May 2019
  - NRC completed their review and issued a formal Safety Evaluation in August 2020
  - Final “approved” version of the topical report was issued in November 2020: https://www.epri.com/research/products/000000003002019978





TRISO Materials Workshop Planning

- 6th Workshop on TRISO Fuel Materials Properties (formerly High Temperature Gas-Cooled Reactor SiC Material Properties)
- To be held in conjunction with the next FFC PMB meeting
- Tentative location: Cadarache, France
- Tentative date: April/May or October 2022

Thank you for your attention

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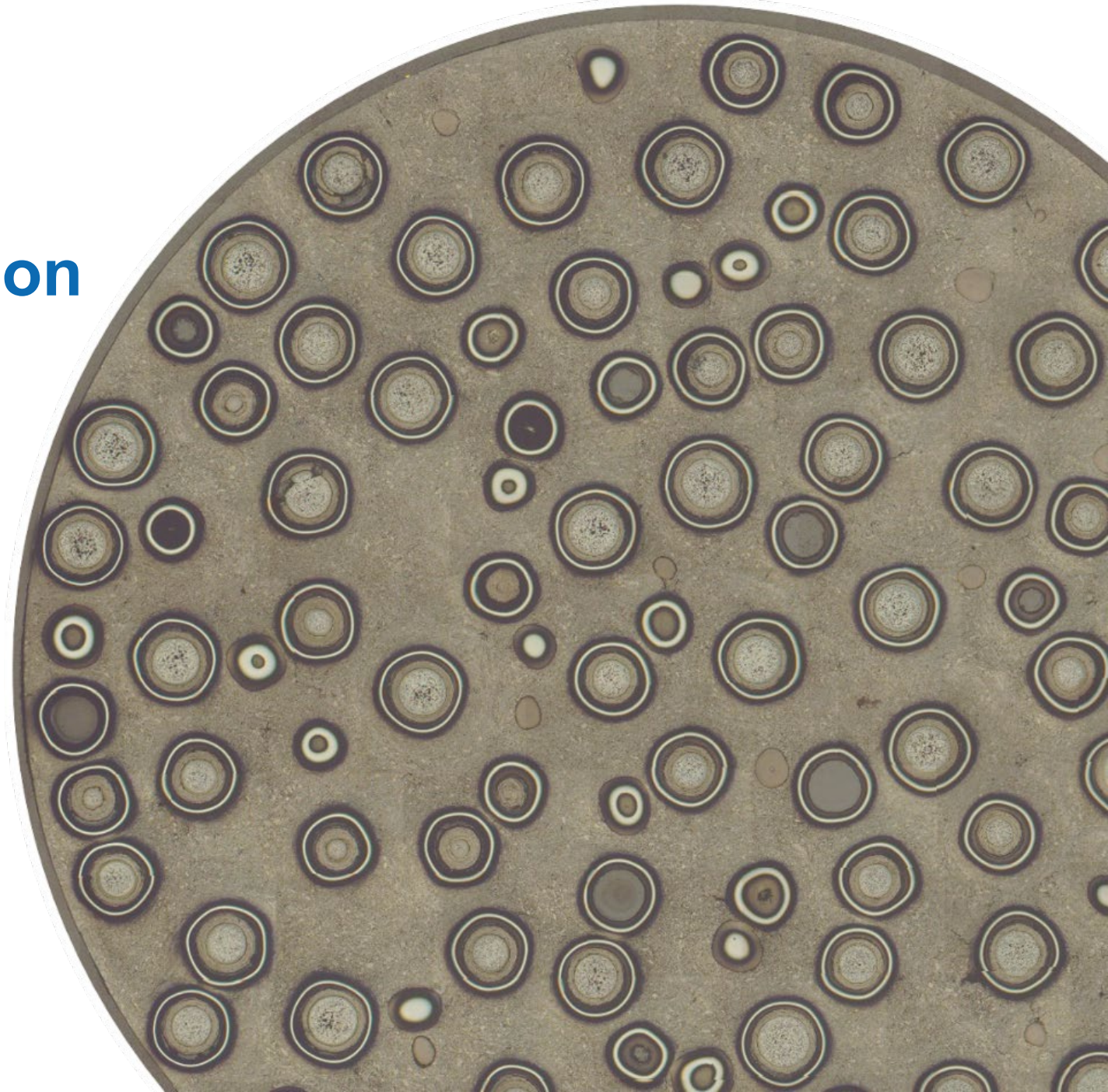

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