INL Advanced Gas Reactor Fuels Program Review

AGR Fuel Development

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Idaho National Laboratory

Contents

- Kernel fabrication
- Path forward to complete fuel fabrication
- Schedule for fuel fabrication

Kernel Forming

- LEU ADUN blending: 7 of 8 completed by end of June
- Half-batch (4-mole) forming runs
  - Operator training
  - Parameter refinement
  - Kernel fissure reduction study using the 2½” sintering furnace
    - ✓ Baseline
    - ✓ Extended wash cycle
    - ✓ Low-temp drying
    - ✓ High-flow calcination

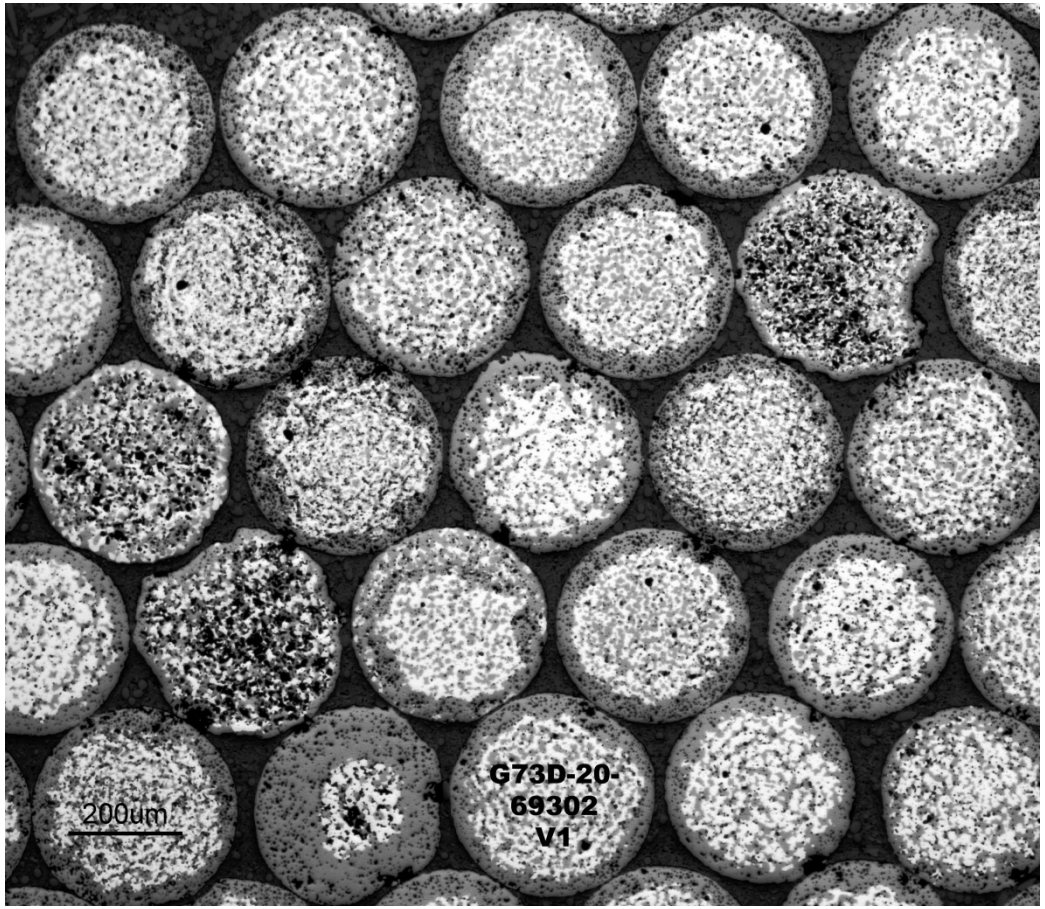
Kernel Forming

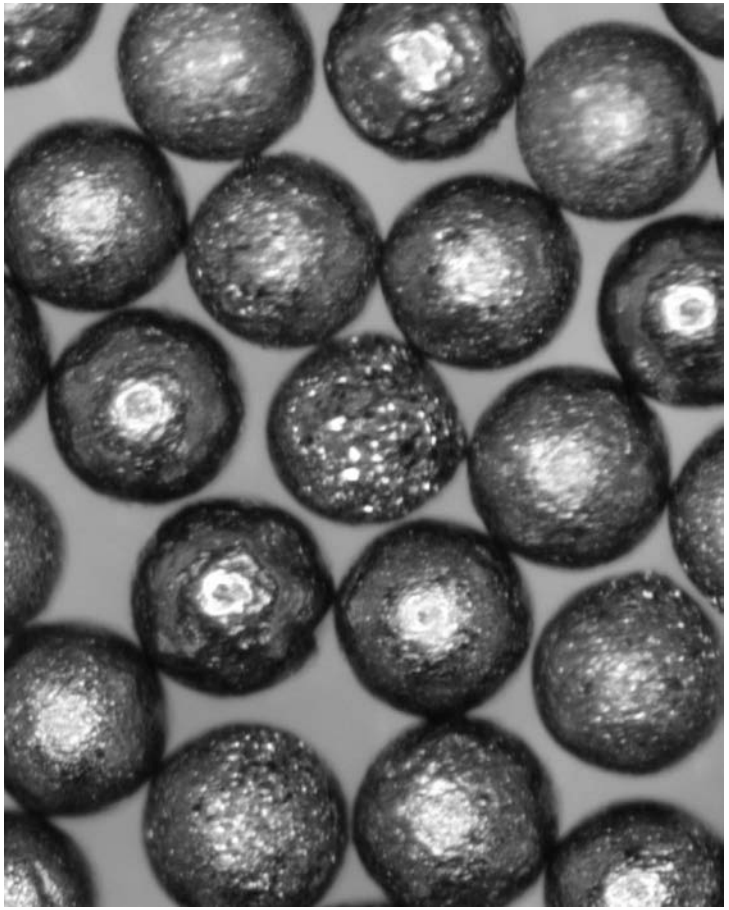
- 3/4-batch (6-mole) forming runs
  - TWEEN 20 surfactant wash
    - Baseline drying and calcination
    - Low-temp drying and baseline calcination
    - Baseline drying and high-flow calcination
- Full (8-mole) production forming runs are pending - based on test outcomes
- Six-inch sintering furnace runs
  - Composited residual gels from 4-mole forming runs
    - Verify furnace operability
    - Assess relationship between kernel properties and furnace
  - Production sintering runs pending

Kernel Batch/Lot Comparison

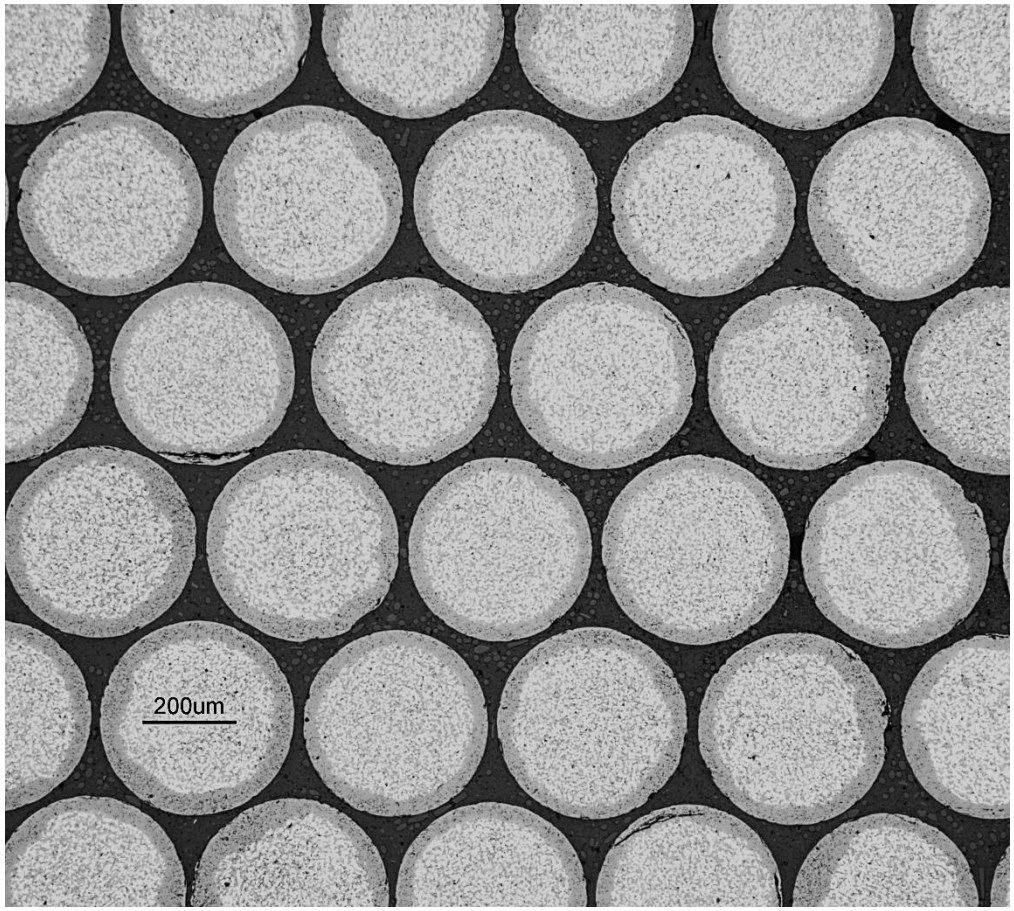
Kernel Lot or Batch	Sample Size	Fissure Fraction (n & 95%)	Crack Fraction (n & 95%)	Density
G73I-14-69307 (AGR-2)	504	2 1.3%	8 3.0%	10.99
J52L-16-69316 (2013)	485	38 10.5%	18 5.7%	10.82
Baseline 59226 (2015)	#1 1105 #2 1127	1 0.4% 0 0.2%	162 16.8% 23 3.0%	11.13
Baseline 59227 (2015) (CO flow control issues)	#1 1022 #2 1138	2 0.6% 1 0.4%	155 16.2% 66 7.3%	11.21
Extended wash 59228 (2015)	1034	0 0.2%	63 7.7%	10.89
Low-temp drying 59229 (2015)	601	0 0.4%	3 1.3%	tap 11.1
High-flow calcination 59230 (2015)	542	2 1.2%	21 5.8%	tap 10.9
Combined 2015 kernels	6569	6 0.2%	----	---

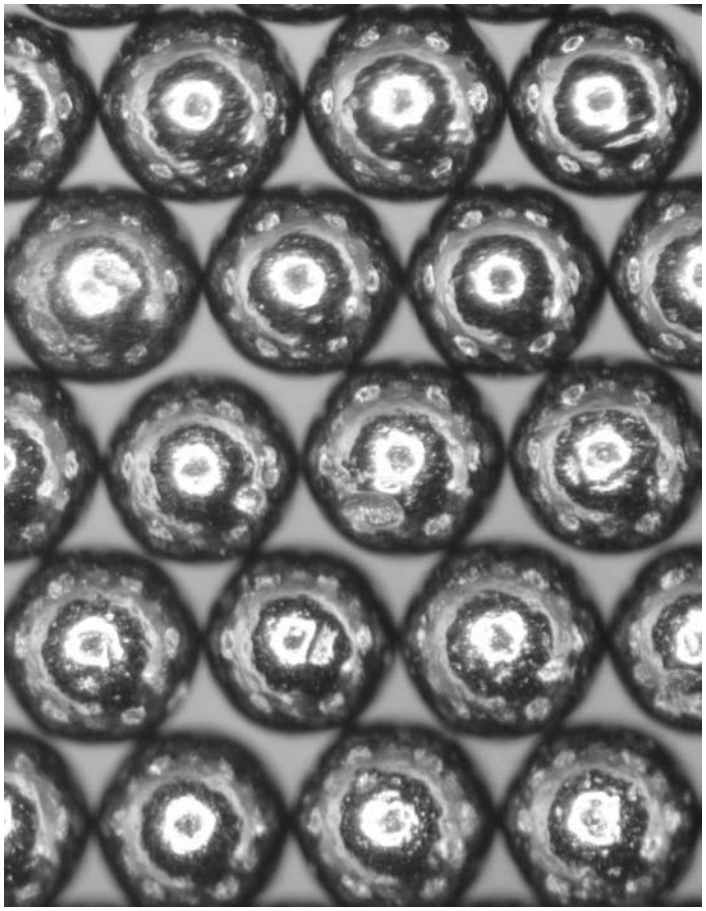
AGR-1 Kernels



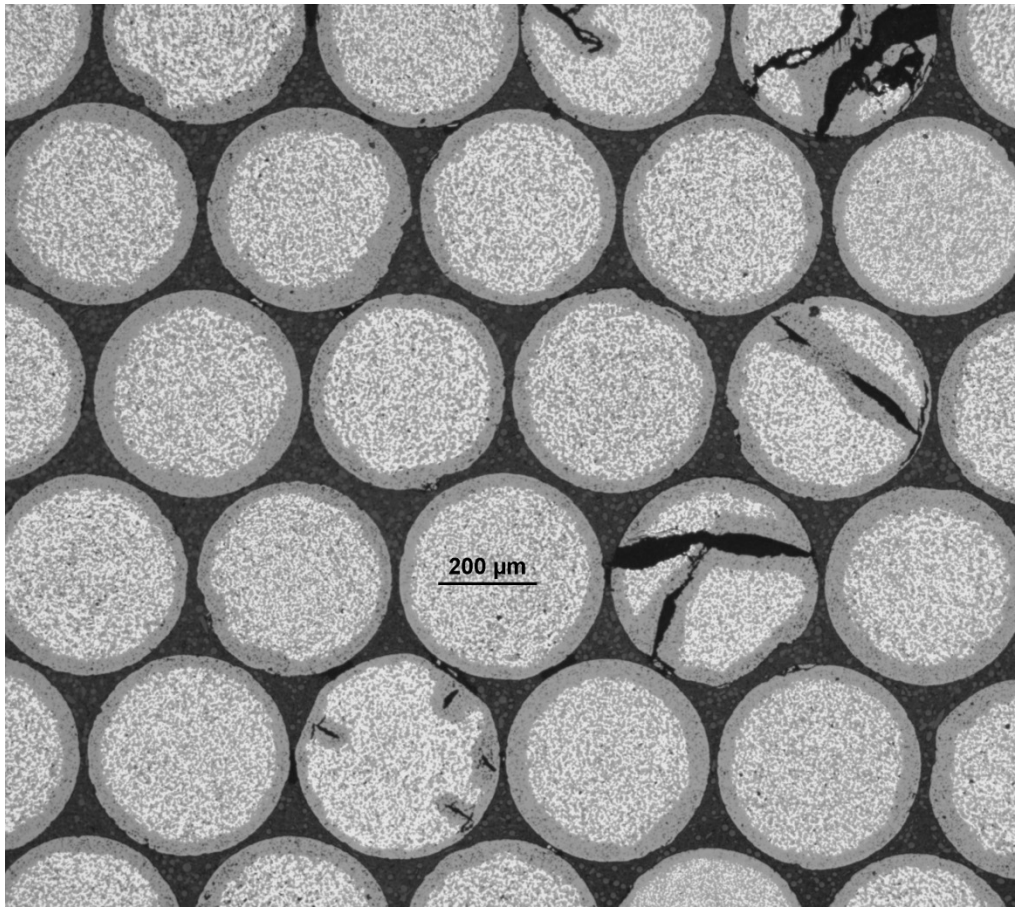


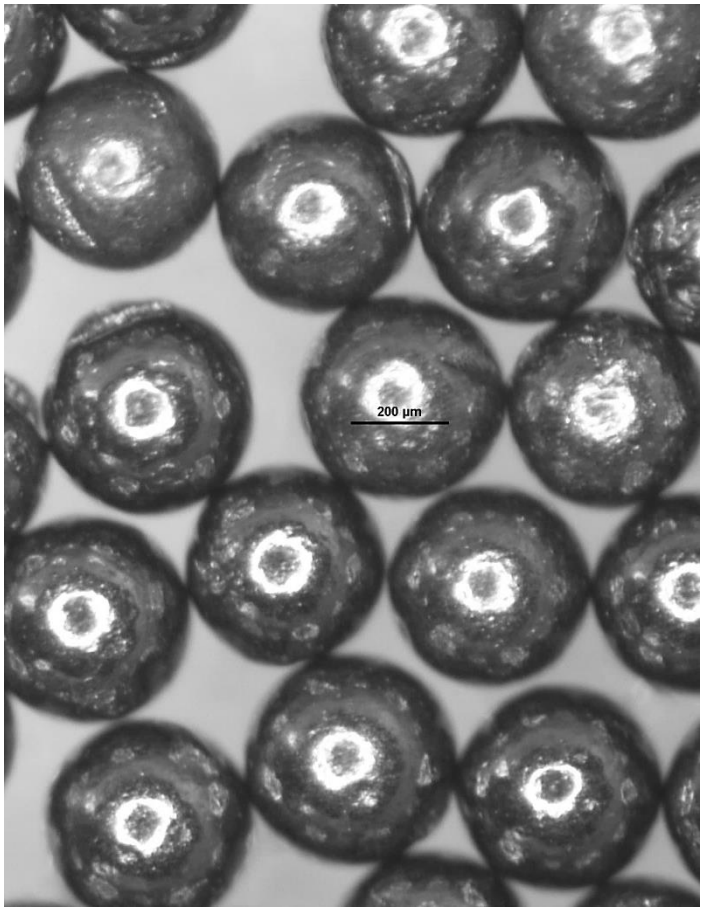
AGR-2 Kernels





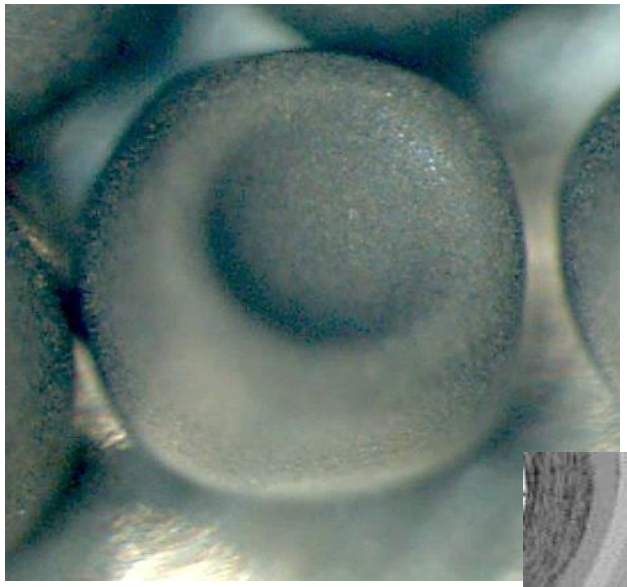
J52L-16-69316 (2013 LEUCO lot)





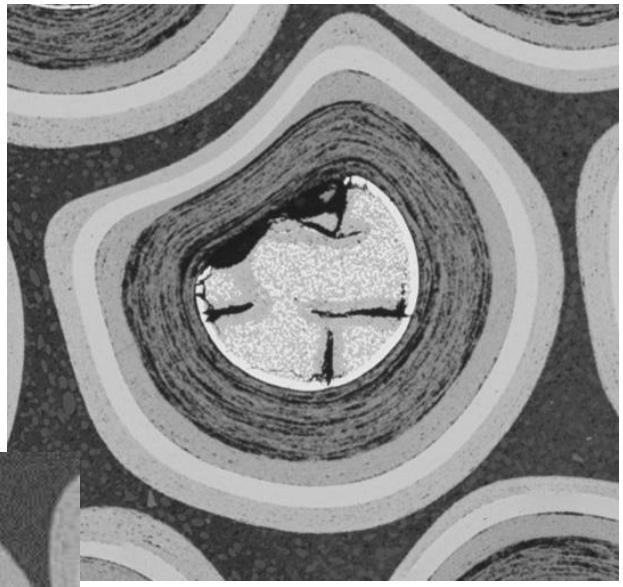
2013 LEUCO lot met all fuel specifications!

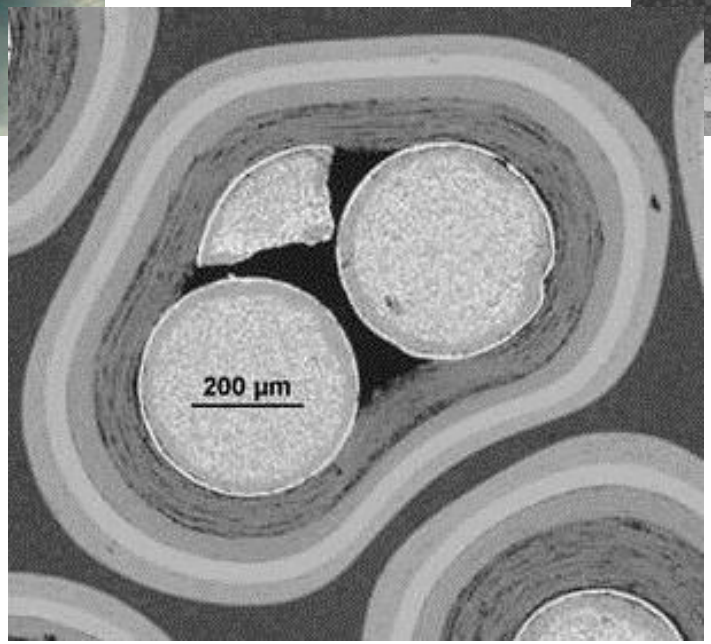
TRISO from the 2013 LEUCO lot



Dimpled Particles

- Thin layers in craters
- Small curvature radius on rim
- Cannot segregate efficiently

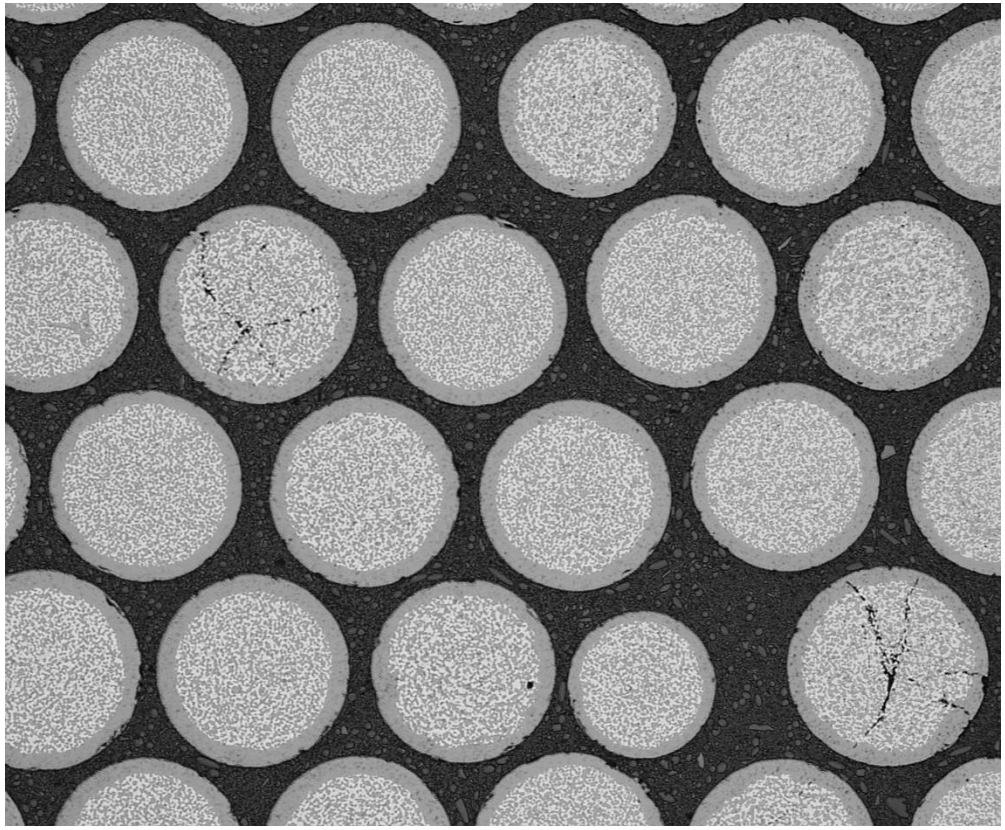


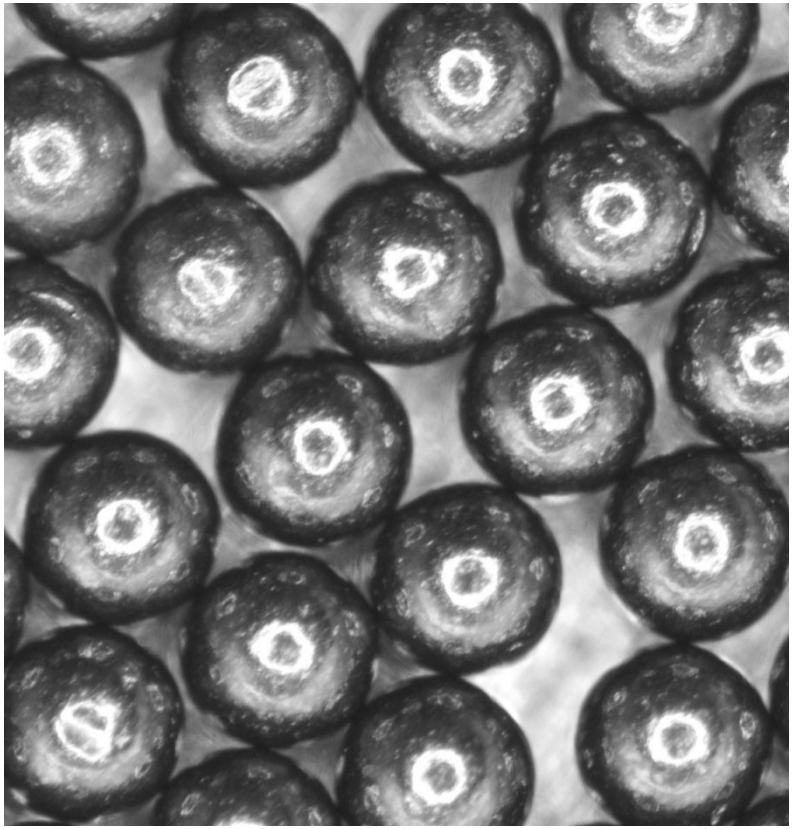


Compounded Kernel

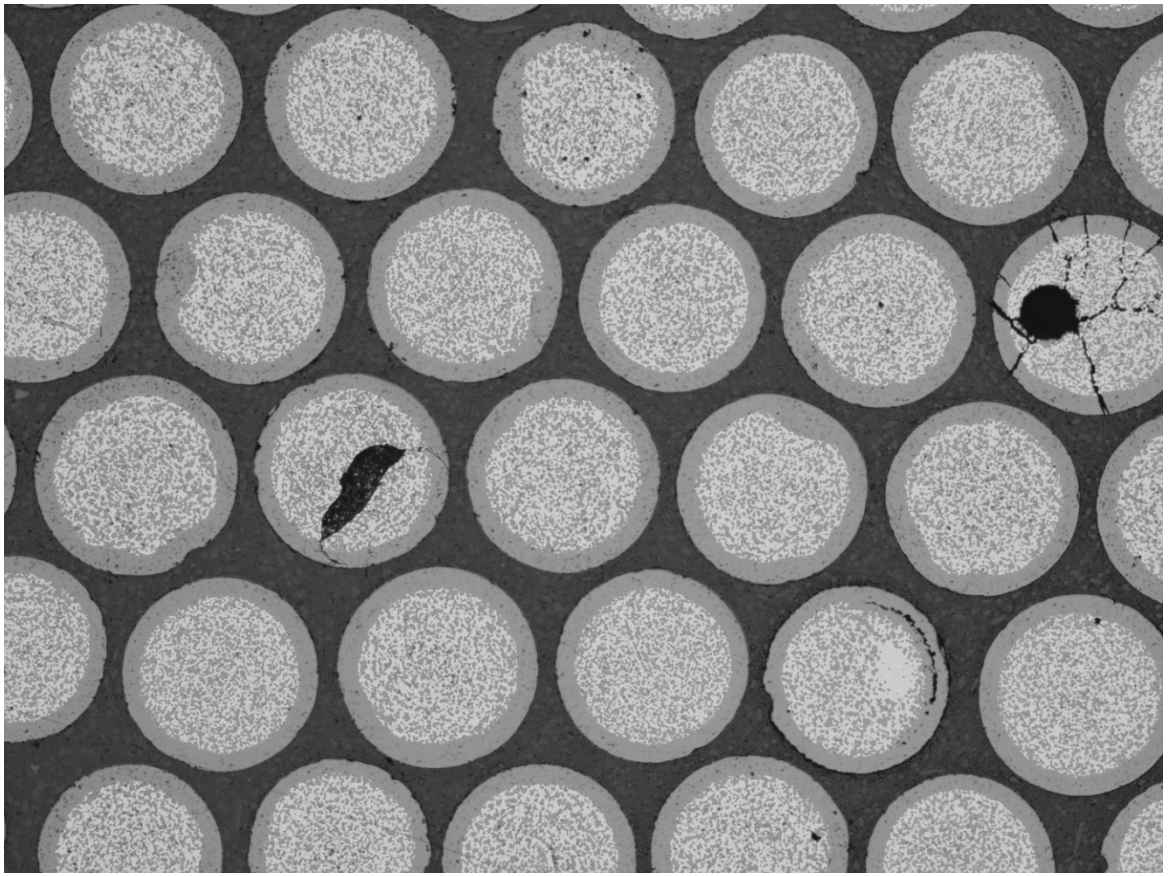
- Full thickness layers
- Easily segregated by sieving

J52R-16-59226 Baseline Kernels (2015)



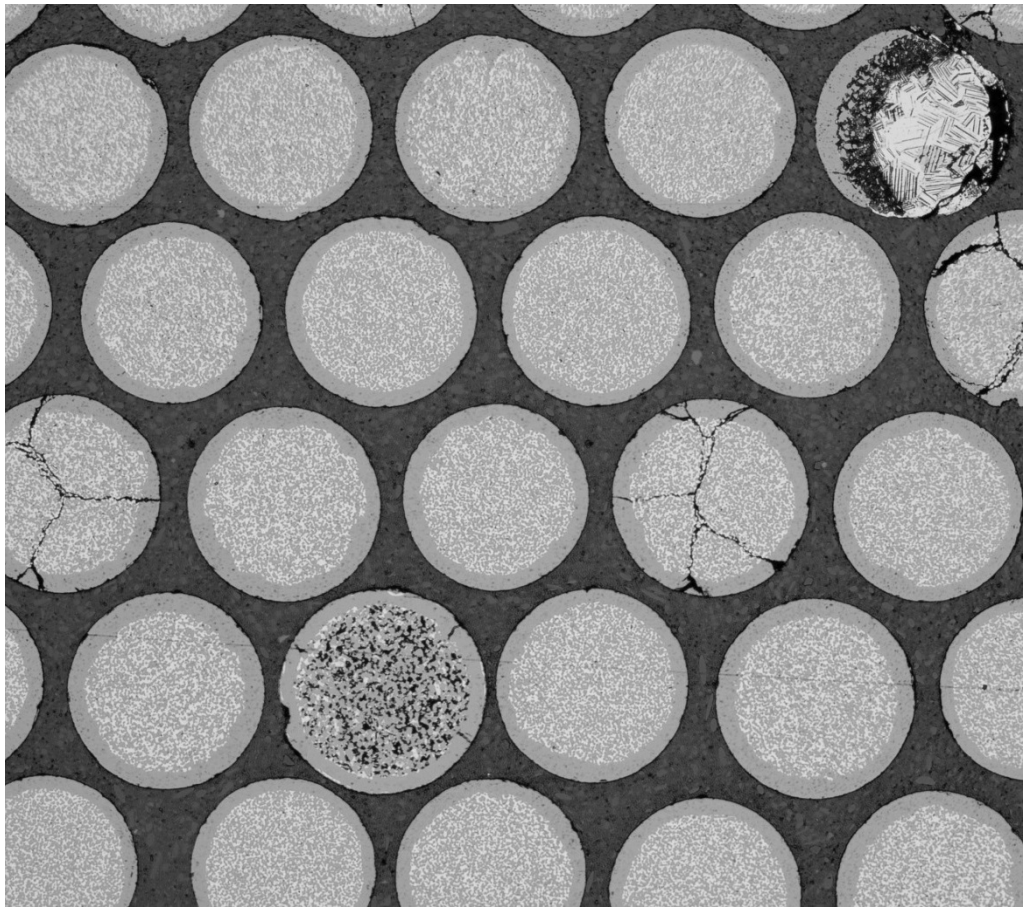


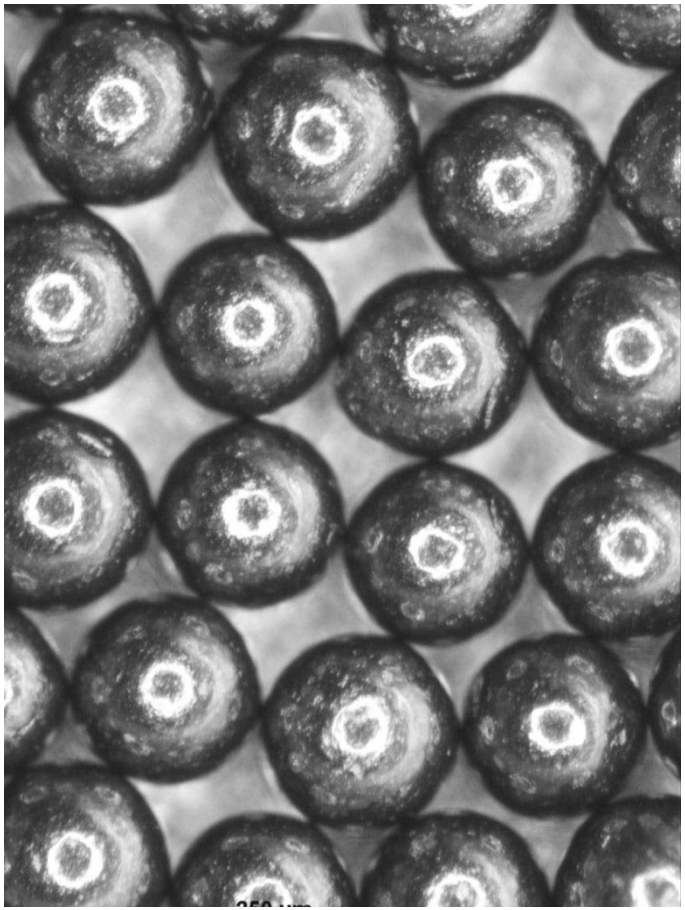
J52R-15-59227 Baseline Kernels (2015)



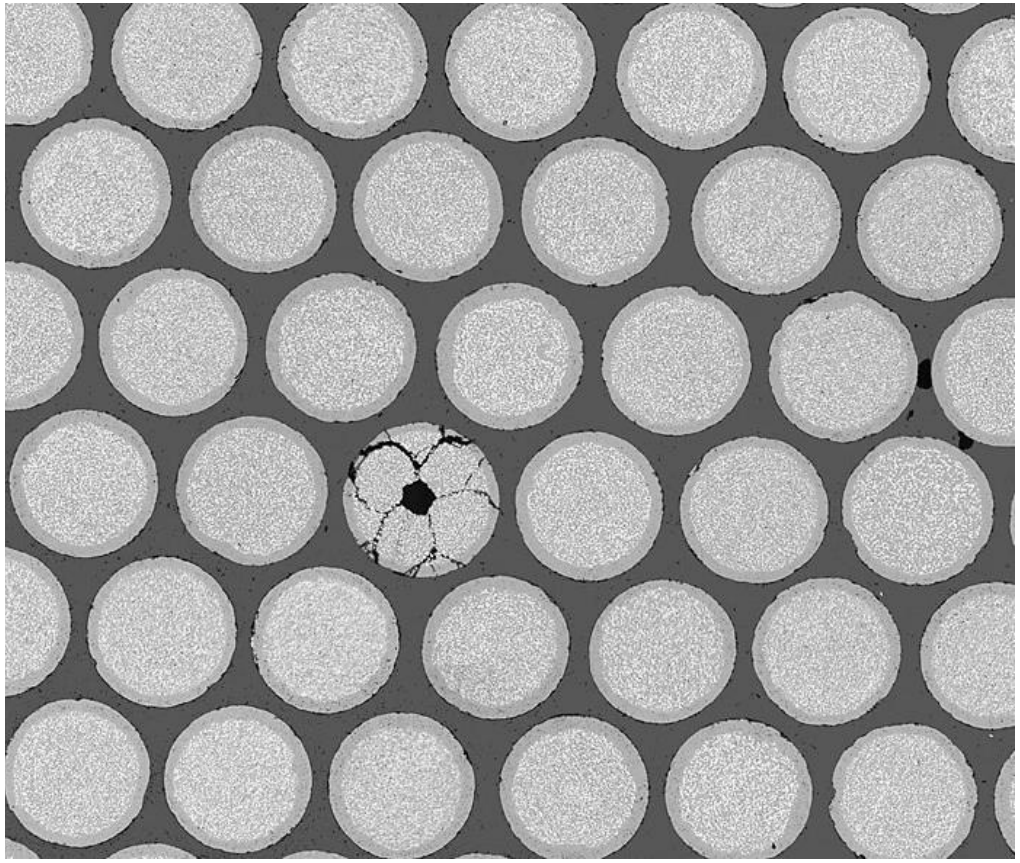
Surface-connected fissures are not being produced

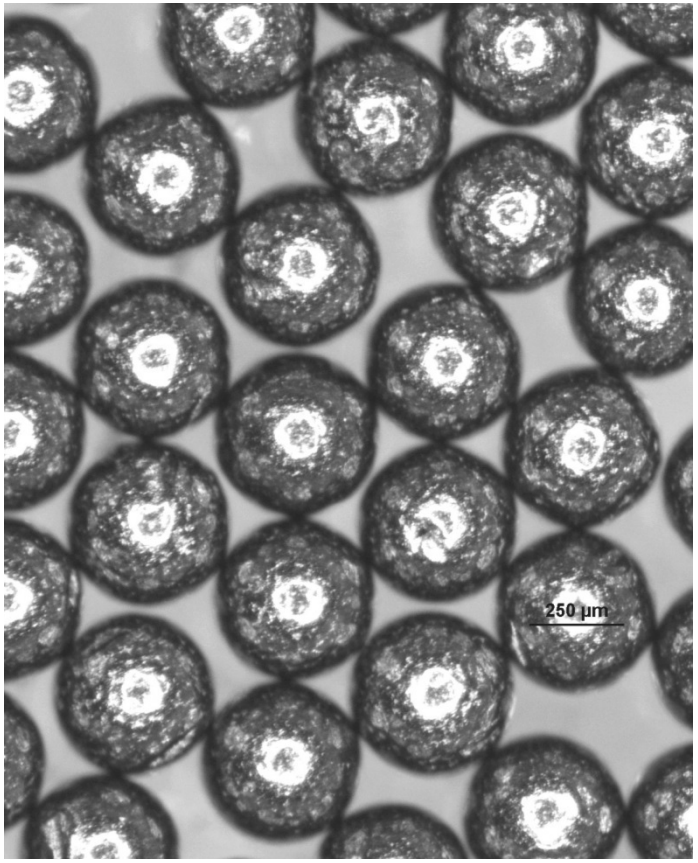
J52R-15-59228 (extended wash cycle, 2015)



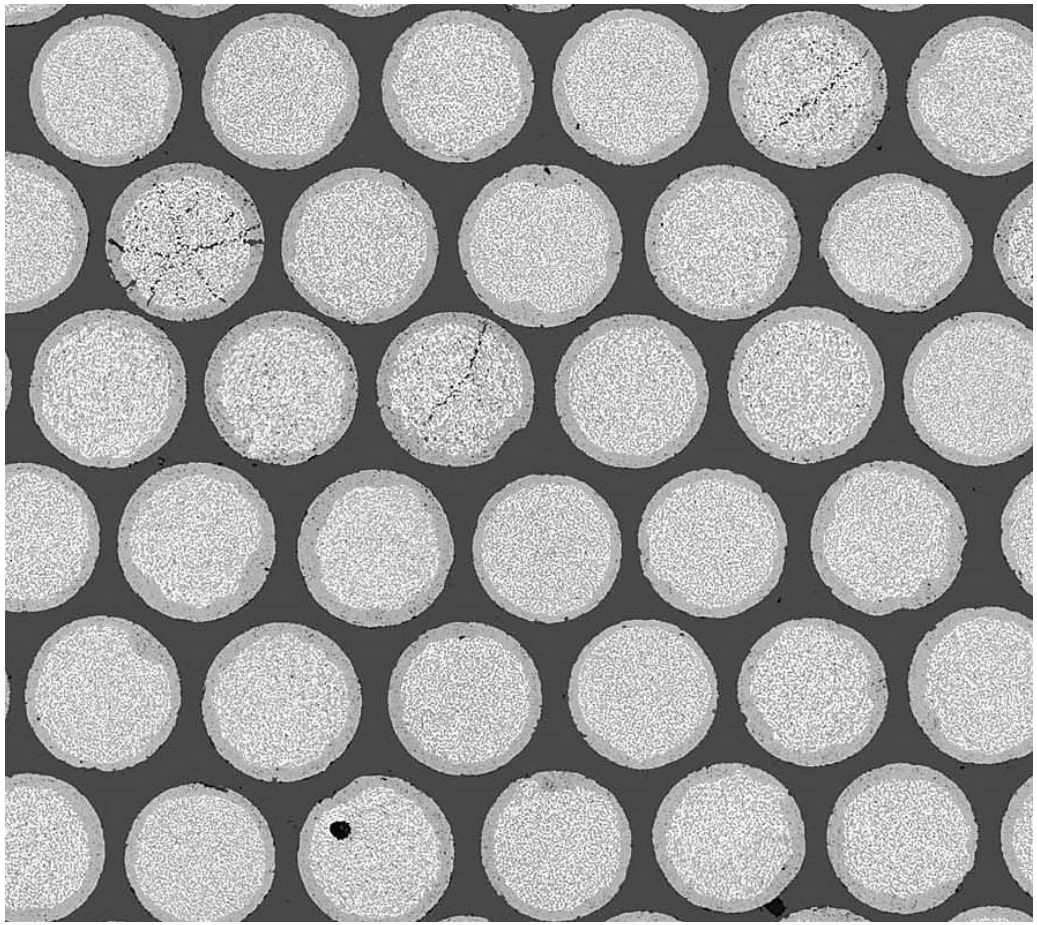


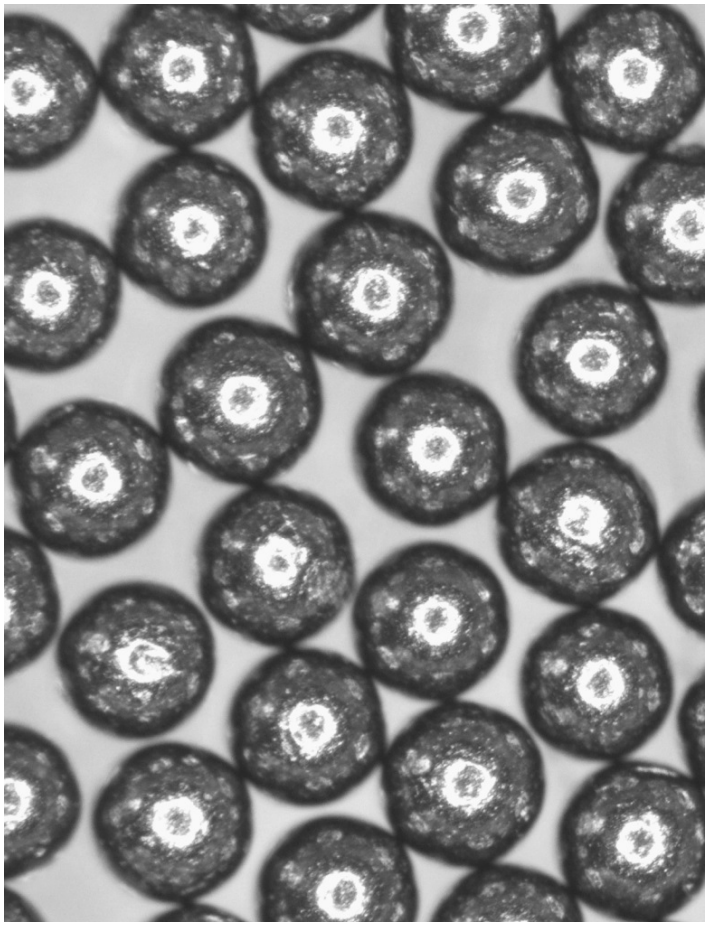
J52R-15-59229 (Cool air dried, 2015)





J52R-15-59230 (High-flow calcination, 2015)





Kernel Defect Reduction in 2015 Kernels

- Only fresh chemicals are used
- Except for broth urea content, the same flowsheet used as with 2013 LEUCO lot (J52L-16-69316)
  - Jack Collins consulted regarding the urea content
  - Literature reviewed
- Cracks form during sample preparation
- Fissure reduction study executed to understand effects of process changes relative to the baseline process
  - Extended wash . . . . . comparable
  - Cool air drying . . . . . reduced cracking
  - High-flow calcination . . . . . comparable
  - TWEEN 20 surfactant wash . . . . . completed

Kernel Defects Reduction in 2015 Kernels

- Kernel friability is expected to be low (kernels are glossy)
- Cracks seen in 2015 kernels were also observed in 2013 LEUCO lot mounts
- Modified polishing procedure reduced cracked kernel incidence by half
  - Artifact of polishing (cracks exist only after polishing)
  - More frangible kernels?
    - No historical compressive strength data for UCO
    - No consequence if they do not fracture in the coating furnace
- Relationship with 2½” sintering furnace is unknown
- Surface-connected fissures are nearly non-existent with the 2015 LEUCO kernels
  - None extend beyond ½ radius
  - Fewer than observed in AGR-2 (G73I-14-69307) mounts

Path Forward

- A 6” sintering run of composited gels completed to compare with 2½” runs
  - Density (tap density looks very good)
  - Defects (pending)
- Form kernels with full, 8-mole ADUN batches
- Recharge sintered kernels into the 2½” furnace
  - Simulate heat-up for buffer coating
  - Quantify kernel fragmentation

Schedule

Material	February Schedule	July Schedule
LEU ADUN blending AGR-5/6/7	June 2015	*June 2015
2½” Sintering run test completion	August 2015	August 2015
LEUCO kernel lot for AGR-5/6/7	December 2015	*December 2015
TRISO lot for AGR-5/6/7	April 2016	*April 2016
40% PF compact lot ready-to-ship	June 2016	**June 2016
25% PF compact lot ready-to-ship	---	August 2016
Experiment train assembly start	---	September 2016
Experiment train ready-to-insert	---	March 2017

* Lot for fabricating AGR-5/6/7. Contingency material available 1 – 2 months later.
** Receipt of compacts at INL in July.

Questions?

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