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ORNL/TM-2006/510

Data Compilation for AGR-1 Variant 3 Compact Lot LEU01-49T-Z

Revision 0

John D. Hunn, Fred C. Montgomery and Peter J. Pappano

August 2006

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Data Compilation for AGR-1 Variant 3 Compact Lot LEU01-49T-Z

J. D. Hunn, F. C. Montgomery and P. J. Pappano
Oak Ridge National Laboratory

This document is a compilation of characterization data for the AGR-1 variant 3 fuel compact lot LEU01-49T-Z. The compacts were produced by ORNL for the Advanced Gas Reactor Fuel Development and Qualification (AGR) program for the first AGR irradiation test train (AGR-1). This compact lot was fabricated using particle composite LEU01-49T, which was a composite of three batches of TRISO-coated 350 μm diameter 19.7% low enrichment uranium oxide/uranium carbide kernels (LEUCO). The AGR-1 TRISO-coated particles consist of a spherical kernel coated with an ~50% dense carbon buffer layer (100 μm nominal thickness), followed by a dense inner pyrocarbon layer (40 μm nominal thickness), followed by a SiC layer (35 μm nominal thickness), followed by another dense outer pyrocarbon layer (40 μm nominal thickness). The kernels were obtained from BWXT and identified as composite G73D-20-69302. The BWXT kernel lot G73D-20-69302 was riffled into sublots for characterization and coating by ORNL and identified as LEU01-## (where ## is a series of integers beginning with 01). A data compilation for the AGR-1 variant 3 coated particle composite LEU01-49T can be found in ORNL/TM-2006/022.

The AGR-1 Fuel Product Specification and Characterization Guidance (INL EDF-4380) provides the requirements necessary for acceptance of the fuel manufactured for the AGR-1 irradiation test. Section 6.2 of EDF-4380 provides the property requirements for the heat treated compacts. The Statistical Sampling Plan for AGR Fuel Materials (INL EDF-4542) provides additional guidance regarding statistical methods for product acceptance and recommended sample sizes. The procedures for characterizing and qualifying the compacts are outlined in ORNL product inspection plan AGR-CHAR-PIP-05. The inspection report forms generated by this product inspection plan document the product acceptance for the property requirements listed in section 6.2 of EDF-4380.

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1 Summary of acceptance test results for LEU01-49T-Z

This section contains inspection report forms (IRFs) associated with the compact lot LEU01-49T-Z. These inspection report forms also appear in a later section of this compilation, accompanied by the associated data report forms (DRFs) showing the results of each individual measurement. These inspection report forms summarize the acceptance testing performed according to the product inspection plan AGR-CHAR-PIP-05. The information in these forms covers all the property specifications listed in section 6.2 of the AGR-1 Fuel Product Specification and Characterization Guidance document INL EDF-4380, Rev. 8. The compact lot, LEU01-49T-Z, was found to meet all the requirements in this section of EDF-4380, Rev. 8.

Table 1-1 is provided for quick reference. It gives the mean values of key variable properties of the compact lot, LEU01-49T-Z. For standard deviations of the distribution of the measured values see the appropriate IRF or DRF. For discussions on the uncertainty in these values, see the associated data acquisition methods and data report forms.

Table 1-1: Quick reference table for key variable properties of LEU01-49T-Z.

Property	Mean
Mean uranium loading (g U/compact)	0.912
Compact diameter (mm)	12.34
Compact length (mm)	25.22
Compact mass (g)	5.59
Impurity content	Table 1-2

The mean impurity levels for the fuel compacts reported on IRF-05A and IRF-05B are probably higher than the actual values for two reasons. First, the as-reported mean impurity levels do not reflect the fact that some of the measurements were at or below the measurement threshold and could not be differentiated from zero. Second, the as-reported mean impurity levels do not account for impurities introduced during the analysis.

Each time a leach was performed, a blank run was also performed where all the relevant wet chemistry steps in the leach-burn-leach procedure in AGR-CHAR-DAM-26R0 were performed without a compact present in order to obtain background values for the analyzed impurities. Table 1-2 shows the total as-reported mean and standard deviation for each measured impurity as well as the total mean values adjusted by subtracting the background values obtained from the associated blank runs. In cases where the value for the blank run was reported as being below a certain measurement threshold value, a minimum value for that leach was calculated by subtracting the threshold value and a maximum value was calculated by subtracting zero. The adjusted mean therefore accounts for all the measurable impurities in the blanks and spans a range that reflects the uncertainty due to the measurement thresholds.

Table 1-2: Mean impurity levels for fuel compacts from LEU-49T-Z compact lot measured by deconsolidation leach-burn-leach technique.

Measured Impurity	As-reported Mean	Adjusted Mean	
		Mininum	Maximum
Fe outside SiC (µg/compact):	3.72 ± 1.67	1.81 ± 1.58	1.81 ± 1.58
Cr outside SiC (µg/compact):	0.28 ± 0.05	0.15 ± 0.04	0.18 ± 0.05
Mn outside SiC (µg/compact):	0.08 ± 0.02	0.02 ± 0.02	0.05 ± 0.04
Co outside SiC (µg/compact):	0.058 ± 0.001	0.000 ± 0.000	0.058 ± 0.001
Ni outside SiC (µg/compact):	1.37 ± 0.24	0.61 ± 0.61	0.61 ± 0.61
Cr+Mn+Co+Ni outside SiC (µg/compact):	1.78 ± 0.22	0.78 ± 0.60	0.90 ± 0.62
Ca outside SiC (µg/compact):	21.69 ± 2.20	5.64 ± 4.61	10.10 ± 9.52
Al outside SiC (µg/compact):	10.27 ± 0.81	7.38 ± 0.88	7.46 ± 0.94
Ti outside SiC (µg/compact):	16.72 ± 0.91	16.52 ± 0.91	16.52 ± 0.91
V outside SiC (µg/compact):	22.43 ± 0.56	22.35 ± 0.58	22.38 ± 0.59
Ti + V outside SiC (µg/compact):	39.15 ± 1.35	38.86 ± 1.35	38.90 ± 1.36

Table 1-3 is also provided for quick reference. It gives the upper limit of the 95% confidence interval of the defect fraction for key attribute properties of the compact lot LEU01-49T-Z. In other words, these values are the lowest tolerance limits for which the compact lot would be deemed acceptable at 95% confidence based on the particular sample that was measured. For the actual number of trials and number of failures observed, see the inspection report form for the compact lot.

Table 1-3: Quick reference table for key attribute properties of LEU01-49T-Z.

Property	Defect Fraction
Uranium contamination fraction	$\leq 3.1 \cdot 10^{-5}$
Defective SiC coating fraction	$\leq 6.1 \cdot 10^{-5}$
Defective IPyC coating fraction	$\leq 6.1 \cdot 10^{-5}$
Defective OPyC coating fraction	$\leq 7.3 \cdot 10^{-4}$

Also worthy of note is the observation of particles with SiC layers less than 20 μm thick. These were observed and noted for information only during x-ray analysis for uranium dispersion after compacting due to defective IPyC. In terms of the upper limit of the 95% confidence interval of the anomaly fraction, as reported in Table 1-3, the fraction of particles in the compact lot with SiC <20 μm thick is $\leq 1.0 \cdot 10^{-3}$. This anomaly is probably caused by particles being temporarily trapped in carbon soot that has built up on the walls of the coating chamber above the fluidized particle bed. This is the same mechanism thought to cause soot inclusions (goldspots) within the SiC layer.

DRF-24 indicates that all compacts met the dimensional specifications in EDF-4380, Rev. 8. Table 1-4 lists the compacts that are available for irradiation sorted in order of increasing length.

Table 1-4: Compacts from LEU-49T-Z compact lot available for irradiation sorted by length

Compact ID Number	Length (mm)	Diameter (mm)						Pass Thru? (Y or N)	Mass (g)	Accept? (pass or fail)
		Top 1	Top 2	Middle 1	Middle 2	Bottom 1	Bottom 2			
59	25.125	12.35	12.34	12.35	12.35	12.33	12.32	Y	5.5644	pass
67	25.126	12.34	12.34	12.34	12.34	12.32	12.32	Y	5.5623	pass
52	25.161	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5794	pass
61	25.161	12.34	12.34	12.34	12.34	12.31	12.31	Y	5.5779	pass
21	25.163	12.34	12.34	12.35	12.35	12.33	12.32	Y	5.5620	pass
76	25.165	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5945	pass
44	25.172	12.34	12.33	12.34	12.34	12.33	12.33	Y	5.5681	pass
18	25.173	12.34	12.34	12.34	12.34	12.33	12.32	y	5.5962	pass
14	25.182	12.34	12.34	12.35	12.34	12.34	12.33	Y	5.6120	pass
43	25.182	12.35	12.35	12.34	12.34	12.33	12.33	Y	5.5659	pass
17	25.187	12.34	12.34	12.35	12.35	12.33	12.33	Y	5.6082	pass
69	25.187	12.34	12.34	12.34	12.34	12.34	12.34	Y	5.6003	pass
73	25.192	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5979	pass
62	25.199	12.34	12.34	12.34	12.34	12.31	12.33	Y	5.5709	pass
33	25.203	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5597	pass
34	25.203	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5624	pass
79	25.208	12.34	12.34	12.34	12.35	12.32	12.33	Y	5.6035	pass
60	25.209	12.33	12.34	12.34	12.34	12.32	12.33	Y	5.5516	pass
37	25.215	12.34	12.34	12.34	12.34	12.33	12.32	Y	5.5649	pass
05	25.218	12.34	12.34	12.34	12.34	12.32	12.32	Y	5.5582	pass
64	25.218	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5716	pass
38	25.219	12.34	12.34	12.33	12.34	12.33	12.33	Y	5.5573	pass
19	25.224	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.6048	pass
28	25.224	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.6060	pass
02	25.231	12.34	12.34	12.34	12.34	12.33	12.34	Y	5.5719	pass
65	25.231	12.35	12.34	12.34	12.34	12.32	12.32	Y	5.6062	pass
39	25.232	12.34	12.34	12.34	12.34	12.33	12.32	Y	5.5829	pass
68	25.232	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.6026	pass
04	25.233	12.34	12.34	12.34	12.34	12.32	12.32	Y	5.5885	pass
09	25.233	12.34	12.34	12.34	12.34	12.32	12.32	Y	5.5803	pass
49	25.233	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5874	pass
72	25.233	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5839	pass
01	25.236	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5957	pass
66	25.236	12.35	12.34	12.34	12.34	12.33	12.33	Y	5.5605	pass
03	25.242	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5973	pass
16	25.245	12.34	12.34	12.35	12.35	12.34	12.33	Y	5.6286	pass
29	25.246	12.34	12.34	12.34	12.34	12.32	12.33	Y	5.5894	pass
54	25.252	12.34	12.35	12.35	12.35	12.34	12.34	Y	5.6898	pass
36	25.253	12.35	12.34	12.34	12.35	12.33	12.33	Y	5.6065	pass
58	25.253	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.6177	pass
30	25.255	12.35	12.34	12.33	12.34	12.33	12.33	Y	5.5886	pass
20	25.256	12.35	12.35	12.34	12.34	12.33	12.33	Y	5.5825	pass
25	25.259	12.34	12.34	12.34	12.34	12.33	12.32	Y	5.6068	pass
41	25.274	12.34	12.34	12.34	12.34	12.32	12.33	Y	5.5729	pass
24	25.289	12.34	12.34	12.35	12.34	12.33	12.33	Y	5.5936	pass
77	25.298	12.34	12.34	12.34	12.34	12.34	12.33	Y	5.6297	pass
46	25.302	12.35	12.34	12.34	12.34	12.32	12.33	Y	5.5974	pass
27	25.304	12.34	12.34	12.35	12.34	12.33	12.33	Y	5.6112	pass

Inspection Report Form IRF-05A: Fuel Compact Lots

Procedure:	AGR-CHAR-PIP-05 Rev. 0
Compact lot ID:	LEU01-49T-Z
Compact lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T
Compact ID numbers of compacts available for irradiation test (pending acceptance):	01,02,03,04,05,09,14,16,17,18,19,20,21,24,25,27,28,29,30,33,34,36,37,38 39,41,43,44,46,49,52,54,58,59,60,61,62,64,65,66,67,68,69,72,73,76,77,79

Property	Measured Data: Mean (x)	Std. Dev. (s)	Measurements (n)	k or t value	Specification: INL EDF-4380 Rev. 8	Acceptance Criteria	Acceptance Test Value	Pass or fail	Data Records
Compact diameter (mm)	See DRF-24				12.22 - 12.46	all available for irradiation test meet specification		pass	DRF-24
Compact length (mm)					25.02 - 25.40				
Uranium loading (gU/compact)	0.912	0.002	6	2.015	0.905 ± 0.04	A = x - ts/√n ≥ 0.865	0.910	pass	DRF-25
						B = x + ts/√n ≤ 0.945	0.914	pass	
Iron content outside SiC (µg/compact)	3.72	1.67	4	2.353	mean ≤ 25	B = x + ts/√n ≤ 25	5.7	pass	IRF-05B DRF-26
				7.042	dispersion ≤0.01 ≥ 100	D = x + √3ks < 100	24.1	pass	
Chromium content outside SiC (µg/compact)	0.28	0.05	4	2.353	mean ≤ 75	B = x + ts/√n ≤ 75	0.3	pass	IRF-05B DRF-26
Manganese content outside SiC (µg/compact)	0.08	0.02	4	2.353	mean ≤ 75	B = x + ts/√n ≤ 75	0.1	pass	IRF-05B DRF-26
Cobalt content outside SiC (µg/compact)	0.058	0.001	4	2.353	mean ≤ 75	B = x + ts/√n ≤ 75	0.1	pass	IRF-05B DRF-26
Nickel content outside SiC (µg/compact)	1.37	0.24	4	2.353	mean ≤ 75	B = x + ts/√n ≤ 75	1.7	pass	IRF-05B DRF-26
Cr + Mn + Co + Ni content outside SiC (µg/compact)	1.78	0.22	4	7.042	dispersion ≤0.01 ≥ 300	D = x + √3ks < 300	4.5	pass	IRF-05B DRF-26
Calcium content outside SiC (µg/compact)	21.69	2.20	4	2.353	mean ≤ 90	B = x + ts/√n ≤ 90	24.3	pass	IRF-05B DRF-26
Aluminum content outside SiC (µg/compact)	10.27	0.81	4	2.353	mean ≤ 45	B = x + ts/√n ≤ 45	11.2	pass	IRF-05B DRF-26
Ti + V content outside SiC (µg/compact)	39.15	1.35	4	2.353	mean ≤ 400	B = x + ts/√n ≤ 400	40.7	pass	IRF-05B DRF-26

Property	Measured Data: # of compacts	# of particles	Specification: INL EDF-4380	Acceptance Criteria	Acceptance Test Value	Pass or fail	Data Records
Uranium contamination fraction (g exposed U/gram U in compact)	24	99032	$\leq 1.0 \times 10^{-4}$	≤4 effectively exposed kernels in ≥91533 particles	0	pass	IRF-05C DRF-26
Defective SiC coating fraction (fraction of total particles)	12	49516	$\leq 2.0 \times 10^{-4}$	≤4 leached kernels in ≥45766 particles or ≤12 leached kernels in ≥97210 particles	0	pass	IRF-05D DRF-26
Defective IPyC coating fraction (fraction of total particles)	12	49516	$\leq 2.0 \times 10^{-4}$	≤4 with excessive U dispersion in ≥45766 particles or ≤12 with excessive U dispersion in ≥97210 particles	0	pass	DRF-28
Defective OPyC coating fraction (fraction of total particles)	1	4126	≤ 0.01	≤6 cracked or missing OPyC in ≥1182 particles or ≤30 cracked or missing OPyC in ≥4064 particles	0	pass	DRF-27

Comments
Note 1: Per EDF-4380, a specification on Cl content outside SiC is not applicable because HCl cleaning of compacts was not performed.

John Thorn — QC Supervisor

8-21-06 — Date

Accept compact lot (Yes or No):	Yes

Mark C Davis — QA Reviewer

8/21/06 — Date

Inspection Report Form IRF-05B: Summary of Impurites Outside SiC

Procedure:	AGR-CHAR-PIP-05 Rev. 0
Operator:	Fred Montgomery
Compact lot ID:	LEU01-49T-Z
Compact Lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T

Compact ID numbers:	22, 57, 74	51, 53, 71	15, 40, 48	11, 31, 35	Mean	Standard Deviation
Number of compacts:	3	3	3	3		
Iron						
Deconsolidation-leach (DRF-26A) (µg):	3.87	3.02	4.25	8.63		
Burn-leach (DRF-26B) (µg):	14.06	3.00	5.15	2.72		
Total leached (µg):	17.93	6.02	9.40	11.35		
Fe outside SiC (µg/compact):	**5.98**	**2.01**	**3.13**	**3.78**	**3.72**	**1.67**
Chromium						
Deconsolidation-leach (DRF-26A) (µg):	0.39	0.43	0.44	0.66		
Burn-leach (DRF-26B) (µg):	0.32	0.35	0.36	0.37		
Total leached (µg):	0.71	0.78	0.81	1.02		
Cr outside SiC (µg/compact):	**0.24**	**0.26**	**0.27**	**0.34**	**0.28**	**0.05**
Manganese						
Deconsolidation-leach (DRF-26A) (µg):	0.17	0.12	0.13	0.18		
Burn-leach (DRF-26B) (µg):	0.16	0.05	0.08	0.05		
Total leached (µg):	0.33	0.18	0.21	0.23		
Mn outside SiC (µg/compact):	**0.11**	**0.06**	**0.07**	**0.08**	**0.08**	**0.02**
Cobalt						
Deconsolidation-leach (DRF-26A) (µg):	0.13	0.12	0.13	0.12		
Burn-leach (DRF-26B) (µg):	0.05	0.05	0.05	0.05		
Total leached (µg):	0.18	0.17	0.18	0.17		
Co outside SiC (µg/compact):	**0.06**	**0.06**	**0.06**	**0.06**	**0.06**	**0.00**
Nickel						
Deconsolidation-leach (DRF-26A) (µg):	1.49	0.91	0.84	0.96		
Burn-leach (DRF-26B) (µg):	2.98	2.85	4.08	2.33		
Total leached (µg):	4.47	3.76	4.92	3.29		
Ni outside SiC (µg/compact):	**1.49**	**1.25**	**1.64**	**1.10**	**1.37**	**0.24**
Transition Metals						
Cr+Mn+Co+Ni outside SiC (µg/compact):	**1.90**	**1.63**	**2.04**	**1.57**	**1.78**	**0.22**
Calcium						
Deconsolidation-leach (DRF-26A) (µg):	35.00	41.20	32.50	49.00		
Burn-leach (DRF-26B) (µg):	26.00	23.40	27.62	25.52		
Total leached (µg):	61.00	64.60	60.12	74.52		
Ca outside SiC (µg/compact):	**20.33**	**21.53**	**20.04**	**24.84**	**21.69**	**2.20**
Aluminum						
Deconsolidation-leach (DRF-26A) (µg):	20.91	22.60	18.26	21.52		
Burn-leach (DRF-26B) (µg):	9.31	10.31	9.37	10.98		
Total leached (µg):	30.22	32.91	27.63	32.50		
Al outside SiC (µg/compact):	**10.07**	**10.97**	**9.21**	**10.83**	**10.27**	**0.81**
Titanium						
Deconsolidation-leach (DRF-26A) (µg):	35.82	29.41	30.32	35.58		
Burn-leach (DRF-26B) (µg):	15.69	18.11	17.98	17.76		
Total leached (µg):	51.51	47.52	48.30	53.34		
Ti outside SiC (µg/compact):	**17.17**	**15.84**	**16.10**	**17.78**	**16.72**	**0.91**
Vanadium						
Deconsolidation-leach (DRF-26A) (µg):	34.65	33.11	34.10	34.35		
Burn-leach (DRF-26B) (µg):	33.89	34.30	30.77	34.00		
Total leached (µg):	68.54	67.41	64.87	68.35		
V outside SiC (µg/compact):	**22.85**	**22.47**	**21.62**	**22.78**	**22.43**	**0.56**
Titanium and Vanadium						
Ti + V outside SiC (µg/compact):	**40.02**	**38.31**	**37.72**	**40.56**	**39.15**	**1.35**

QC Supervisor

8-21-06

Date

Inspection Report Form IRF-05C: Summary of Uranium Contamination

Procedure:	AGR-CHAR-PIP-05 Rev. 0
Operator:	Fred Montgomery
Compact lot ID:	LEU01-49T-Z
Compact Lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T

Compact ID numbers:	22, 57, 74	51, 53, 71	15, 40, 48	11, 31, 35	6, 8, 10, 13, 55, 78	7, 32, 45, 47, 56, 75	Total
Number of compacts:	3	3	3	3	6	6	24
Effective number of exposed kernels:	0.0	0.0	0.0	0.0	0.0	0.0	0.0

QC Supervisor

8-21-06

Date

Inspection Report Form IRF-05D: Summary of SiC Burn-Leach Defects

Procedure:	AGR-CHAR-PIP-05 Rev. 0
Operator:	Fred Montgomery
Compact lot ID:	LEU01-49T-Z
Compact Lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T

Compact ID numbers:	22, 57, 74	51, 53, 71	15, 40, 48	11, 31, 35			Total
Number of compacts:	3	3	3	3			12
Number of leached kernels:	0	0	0	0			0

QC Supervisor

8-21-06

Date

2 Compacting process conditions

LEU01-49T (variant 3) TRISO particles were received from the characterization group after removing particles for characterization according to AGR-CHAR-PIP-04R2, "Product Inspection Plan for Coated Particle Composites." Fifteen ~20 g aliquots were prepared via riffling, and one aliquot was used per overcoating run. Prior to overcoating, the particles were washed in methanol per procedure AGR-TRISOWASH-SOP-1, "Standard Operating Procedure for TRISO Particle Washing." Washing of particles prior to overcoating was adapted in order to help reduce the amount of contamination on the particles that may have been acquired during processing or general handling. The washing procedure was adopted from General Atomics' particle washing procedures.

After washing, the LEU01-49T particles were overcoated using matrix batch GKrS 051606. All of the aliquots were overcoated producing 302 g of +18 particles. "+18" particles are those that pass through an ASTM E11 No. 16 sieve (1.18 mm) but do not pass through and ASTM E11 No. 18 sieve (1.00 mm). This quantity of +18 particles was insufficient (based on assumed weight per overcoated particle data and past overcoating experience) to produce 79 compacts, so the oversized and undersized overcoated particles were rinsed with methanol in order to remove the overcoat matrix. Overcoating of reclaimed TRISO particles (TRISO particles from rinsed overcoated particles) was continued until 462 g of +18 particles was produced in total (160g of +18 particles were obtained by overcoating reclaimed TRISO).

The 462 g of +18 particles were then tabled and 415 g of +18 Bin 3 particles were recovered. "Bin 3" particles are those particles that end up in the third bin of the tabler; these are the most spherical of the +18 particles. 415 g of +18 Bin 3 overcoated particles was determined to be a sufficient quantity to produce at least 79 compacts, based on preliminary calculations.

Based on an average kernel weight of $2.42 \cdot 10^{-4}$ g and a wt% uranium of 0.9006 for the AGR-1 kernels, 4151 particles are needed in each compact to obtain a uranium loading of 0.905 g. The average +18 Bin 3 overcoated particle weight was measured (according to AGR-CHAR-DAM-22, "Data Acquisition Method for Estimation of Average Particle Weight") to be $1.21 \cdot 10^{-3}$ g. Using this value, a compact charge of 5.02 g of +18 Bin 3 overcoated particles would be required for a compact uranium loading of 0.905 g. As an alternate approach for calculating the compact charge, a quantity of +18 Bin 3 overcoated particles was rinsed and the ratio of overcoated particle weight to TRISO particle weight was determined to be 1.695. 4151 particles corresponds to 3.014 g TRISO particles (given an average weight of AGR-1 variant 3 TRISO particle of $7.26 \cdot 10^{-4}$ g). Using this second approach, a compact charge of 5.11 g of +18 Bin 3 overcoated particles would be required for a compact uranium loading of 0.905 g. Given that the uranium loading measurements from baseline and variant 1 indicated that the compact charge calculated from the measured average overcoated particle weight (the first approach) was the more accurate method for determining uranium loading, a compact charge of 5.02 g was used to obtain a uranium loading close to 0.905 g.

The 415 g quantity of +18 Bin 3 overcoated particles was rotary riffled into aliquots of approximately 4.15 g. Additional +18 Bin 3 overcoated particles were added to each aliquot by scoop sampling until the desired 5.02 g compact charge was reached. Compacts were then made from the 5.02 g aliquots. Steps were taken in the process to increase the malleability of the overcoat, which helped aid the compaction process, densify the compact, and create a smoother, less porous outer surface. A 0.40 g quantity of matrix powder was added to the compacting mold prior to the addition of overcoated particles. Another 0.40g quantity of matrix was added to the mold after addition of the overcoated particles, such that the overcoated particles were compressed between two matrix "end caps" during fabrication. The compact is pressed by applying force to a top ram. The presence of these end caps helps to buffer the particles during compacting, and also provides a smooth, sharp end in the green compact.

82 AGR-1 variant 3 compacts were fabricated. All of the 82 green compacts were subsequently carbonized and heat treated. 79 compacts were selected from this batch of 82 and delivered to the characterization group. The selection of the 79 compacts for the characterization group was based on length measurements at each stage of compacting (green, carbonization, and heat-treatment), and visual inspection for surface irregularities.

AGR-1 Process Conditions

The AGR-1 process limits from EDF-4380, Rev. 8 are listed below.

AGR-1 Process Limits: Molding Pressure <60 MPa

Carbonization parameters: <350ºC/hr in He
Hold at 950 ± 50ºC for 1.0 ± 0.4 hr
Furnace cool

Heat treatment parameters: ~20ºC/min in vacuum
Hold at 1650-1850ºC for 60 ± 10 min
Furnace cool at ~20ºC/min to below 700ºC

Table 2-1 shows the process conditions used in molding the compacts, carbonizing the compacts, and heat treating the compacts. In the carbonization regime, the furnace was allowed to cool under no power (i.e., after holding at 950°C for 1 hour, power was turned off). In the heat treatment run, the furnace was cooled under power until the furnace temperature reached 700°C. The rate of cooling was 20°C/min.

Conclusion

The LEU01-49T-Z (AGR-1 variant 3) compact lot was made in accordance with the AGR-1 process limits listed in EDF-4380, Rev. 8.

Table 2-1: Summary of process conditions used in making LEU01-49T-Z (AGR-1 variant 3) compacts

Compact ID	Carbonization Parameter					Heat-treatment Parameters			
	Molding Pressure (MPa)	Heating Rate (°C/min.)	Max. Temp. (°C)	Hold Time (hrs.)	Atmosphere	Heating Rate (°C/min.)	Max. Temp. (°C)	Hold Time (hrs.)	Atmosphere
LEU01-49T-Z01	9.65	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z02	9.28	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z03	10.03	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z04	9.65	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z05	9.28	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z06	11.14	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z07	10.03	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z08	11.14	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z09	10.03	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z10	9.28	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z11	9.28	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z12	9.28	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z13	10.40	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z14	11.14	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z15	10.40	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z16	10.77	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z17	11.14	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z18	9.28	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z19	10.40	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z20	9.65	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z21	9.28	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z22	10.03	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z23	9.65	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z24	10.40	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z25	10.03	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z26	9.65	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z27	10.03	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z28	10.40	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z29	10.03	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z30	10.03	4.7	950	1	flowing He	20	1800	1	vacuum

Task Manager Review Peter J. Pappano Date 8-17-06

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Table 2-1 (cont.): Summary of process conditions used in making LEU01-49T-Z (AGR-1 variant 3) compacts

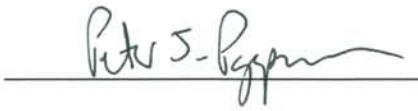
Compact ID	Carbonization Parameter					Heat-treatment Parameters			
	Molding Pressure (MPa)	Heating Rate (°C/min.)	Max. Temp. (°C)	Hold Time (hrs.)	Atmosphere	Heating Rate (°C/min.)	Max. Temp. (°C)	Hold Time (hrs.)	Atmosphere
LEU01-49T-Z31	11.14	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z32	10.03	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z33	9.28	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z34	9.28	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z35	10.77	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z36	10.40	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z37	9.28	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z38	9.65	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z39	10.03	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z40	10.03	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z41	9.65	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z42	11.14	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z43	8.91	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z44	9.65	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z45	10.03	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z46	10.03	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z47	9.65	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z48	10.03	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z49	10.03	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z50	9.28	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z51	10.40	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z52	10.03	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z53	9.65	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z54	11.14	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z55	9.65	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z56	9.65	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z57	9.65	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z58	9.65	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z59	10.77	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z60	9.28	4.7	950	1	flowing He	20	1800	1	vacuum

Task Manager Review Peter J. Pappano Date 8-17-06

QAS Review [signature] Date 8/17/06

Table 2-1 (cont.): Summary of process conditions used in making LEU01-49T-Z (AGR-1 variant 3) compacts

Compact ID	Carbonization Parameter					Heat-treatment Parameters			
	Molding Pressure (MPa)	Heating Rate (°C/min.)	Max. Temp. (°C)	Hold Time (hrs.)	Atmosphere	Heating Rate (°C/min.)	Max. Temp. (°C)	Hold Time (hrs.)	Atmosphere
LEU01-49T-Z61	9.28	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z62	9.28	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z63	10.03	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z64	9.28	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z65	10.03	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z66	9.28	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z67	9.65	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z68	10.40	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z69	10.40	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z70	10.03	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z71	9.65	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z72	9.28	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z73	10.77	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z74	10.40	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z75	10.40	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z76	10.03	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z77	11.14	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z78	10.03	4.7	950	1	flowing He	20	1800	1	vacuum
LEU01-49T-Z79	10.03	4.7	950	1	flowing He	20	1800	1	vacuum

Task Manager Review  Date 8-17-06

QAS Review Date 8/16/06

3 Characterization of compacts

This section contains acceptance testing data on the compact lot LEU01-49T-Z. The data was obtained according to product inspection plan AGR-CHAR-PIP-05R0.

The following pages show the inspection report forms (IRF-05A, IRF-05B, IRF-05C, IRF-05D) for the LEU01-49T-Z compacts. Following the IRF-05 inspection report forms are the individual data report forms for the measurements that were performed. This compact lot was determined to satisfy the specifications in section 6.2 of the AGR-1 Fuel Product Specification and Characterization Guidance document INL EDF-4380, Rev. 8.

Inspection Report Form IRF-05A: Fuel Compact Lots

Procedure:	AGR-CHAR-PIP-05 Rev. 0
Compact lot ID:	LEU01-49T-Z
Compact lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T
Compact ID numbers of compacts available for irradiation test (pending acceptance):	01,02,03,04,05,09,14,16,17,18,19,20,21,24,25,27,28,29,30,33,34,36,37,38 39,41,43,44,46,49,52,54,58,59,60,61,62,64,65,66,67,68,69,72,73,76,77,79

Property	Measured Data Mean (x)	Std. Dev. (s)	Measurements (n)	k or t value	Specification INL EDF-4380 Rev. 8	Acceptance Criteria	Acceptance Test Value	Pass or fail	Data Records
Compact diameter (mm)	See DRF-24				12.22 - 12.46	all available for irradiation test meet specification		pass	DRF-24
Compact length (mm)					25.02 - 25.40				
Uranium loading (gU/compact)	0.912	0.002	6	2.015	0.905 ± 0.04	A = x - ts/√n ≥ 0.865	0.910	pass	DRF-25
						B = x + ts/√n ≤ 0.945	0.914	pass	
Iron content outside SiC (µg/compact)	3.72	1.67	4	2.353	mean ≤ 25	B = x + ts/√n ≤ 25	5.7	pass	IRF-05B DRF-26
				7.042	dispersion ≤0.01 ≥ 100	D = x + √3ks < 100	24.1	pass	
Chromium content outside SiC (µg/compact)	0.28	0.05	4	2.353	mean ≤ 75	B = x + ts/√n ≤ 75	0.3	pass	IRF-05B DRF-26
Manganese content outside SiC (µg/compact)	0.08	0.02	4	2.353	mean ≤ 75	B = x + ts/√n ≤ 75	0.1	pass	IRF-05B DRF-26
Cobalt content outside SiC (µg/compact)	0.058	0.001	4	2.353	mean ≤ 75	B = x + ts/√n ≤ 75	0.1	pass	IRF-05B DRF-26
Nickel content outside SiC (µg/compact)	1.37	0.24	4	2.353	mean ≤ 75	B = x + ts/√n ≤ 75	1.7	pass	IRF-05B DRF-26
Cr + Mn + Co + Ni content outside SiC (µg/compact)	1.78	0.22	4	7.042	dispersion ≤0.01 ≥ 300	D = x + √3ks < 300	4.5	pass	IRF-05B DRF-26
Calcium content outside SiC (µg/compact)	21.69	2.20	4	2.353	mean ≤ 90	B = x + ts/√n ≤ 90	24.3	pass	IRF-05B DRF-26
Aluminum content outside SiC (µg/compact)	10.27	0.81	4	2.353	mean ≤ 45	B = x + ts/√n ≤ 45	11.2	pass	IRF-05B DRF-26
Ti + V content outside SiC (µg/compact)	39.15	1.35	4	2.353	mean ≤ 400	B = x + ts/√n ≤ 400	40.7	pass	IRF-05B DRF-26

Property	Measured Data # of compacts	# of particles	Specification INL EDF-4380	Acceptance Criteria	Acceptance Test Value	Pass or fail	Data Records
Uranium contamination fraction (g exposed U/gram U in compact)	24	99032	≤ 1.0×10^{-4}	≤4 effectively exposed kernels in ≥91533 particles	0	pass	IRF-05C DRF-26
Defective SiC coating fraction (fraction of total particles)	12	49516	≤ 2.0×10^{-4}	≤4 leached kernels in ≥45766 particles or ≤12 leached kernels in ≥97210 particles	0	pass	IRF-05D DRF-26
Defective IPyC coating fraction (fraction of total particles)	12	49516	≤ 2.0×10^{-4}	≤4 with excessive U dispersion in ≥45766 particles or ≤12 with excessive U dispersion in ≥97210 particles	0	pass	DRF-28
Defective OPyC coating fraction (fraction of total particles)	1	4126	≤ 0.01	≤6 cracked or missing OPyC in ≥1182 particles or ≤30 cracked or missing OPyC in ≥4064 particles	0	pass	DRF-27

Comments
Note 1: Per EDF-4380, a specification on Cl content outside SiC is not applicable because HCl cleaning of compacts was not performed.

QC Supervisor — 8-21-06 Date

Accept compact lot (Yes or No):	Yes

QA Reviewer — 8/21/06 Date

Inspection Report Form IRF-05B: Summary of Impurites Outside SiC

Procedure:	AGR-CHAR-PIP-05 Rev. 0
Operator:	Fred Montgomery
Compact lot ID:	LEU01-49T-Z
Compact Lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T

Compact ID numbers:	22, 57, 74	51, 53, 71	15, 40, 48	11, 31, 35	Mean	Standard Deviation
Number of compacts:	3	3	3	3		
Iron						
Deconsolidation-leach (DRF-26A) (µg):	3.87	3.02	4.25	8.63		
Burn-leach (DRF-26B) (µg):	14.06	3.00	5.15	2.72		
Total leached (µg):	17.93	6.02	9.40	11.35		
Fe outside SiC (µg/compact):	**5.98**	**2.01**	**3.13**	**3.78**	**3.72**	**1.67**
Chromium						
Deconsolidation-leach (DRF-26A) (µg):	0.39	0.43	0.44	0.66		
Burn-leach (DRF-26B) (µg):	0.32	0.35	0.36	0.37		
Total leached (µg):	0.71	0.78	0.81	1.02		
Cr outside SiC (µg/compact):	**0.24**	**0.26**	**0.27**	**0.34**	**0.28**	**0.05**
Manganese						
Deconsolidation-leach (DRF-26A) (µg):	0.17	0.12	0.13	0.18		
Burn-leach (DRF-26B) (µg):	0.16	0.05	0.08	0.05		
Total leached (µg):	0.33	0.18	0.21	0.23		
Mn outside SiC (µg/compact):	**0.11**	**0.06**	**0.07**	**0.08**	**0.08**	**0.02**
Cobalt						
Deconsolidation-leach (DRF-26A) (µg):	0.125	0.123	0.128	0.120		
Burn-leach (DRF-26B) (µg):	0.050	0.050	0.050	0.050		
Total leached (µg):	0.175	0.173	0.178	0.170		
Co outside SiC (µg/compact):	**0.058**	**0.058**	**0.059**	**0.057**	**0.058**	**0.001**
Nickel						
Deconsolidation-leach (DRF-26A) (µg):	1.49	0.91	0.84	0.96		
Burn-leach (DRF-26B) (µg):	2.98	2.85	4.08	2.33		
Total leached (µg):	4.47	3.76	4.92	3.29		
Ni outside SiC (µg/compact):	**1.49**	**1.25**	**1.64**	**1.10**	**1.37**	**0.24**
Transition Metals						
Cr+Mn+Co+Ni outside SiC (µg/compact):	**1.90**	**1.63**	**2.04**	**1.57**	**1.78**	**0.22**
Calcium						
Deconsolidation-leach (DRF-26A) (µg):	35.00	41.20	32.50	49.00		
Burn-leach (DRF-26B) (µg):	26.00	23.40	27.62	25.52		
Total leached (µg):	61.00	64.60	60.12	74.52		
Ca outside SiC (µg/compact):	**20.33**	**21.53**	**20.04**	**24.84**	**21.69**	**2.20**
Aluminum						
Deconsolidation-leach (DRF-26A) (µg):	20.91	22.60	18.26	21.52		
Burn-leach (DRF-26B) (µg):	9.31	10.31	9.37	10.98		
Total leached (µg):	30.22	32.91	27.63	32.50		
Al outside SiC (µg/compact):	**10.07**	**10.97**	**9.21**	**10.83**	**10.27**	**0.81**
Titanium						
Deconsolidation-leach (DRF-26A) (µg):	35.82	29.41	30.32	35.58		
Burn-leach (DRF-26B) (µg):	15.69	18.11	17.98	17.76		
Total leached (µg):	51.51	47.52	48.30	53.34		
Ti outside SiC (µg/compact):	**17.17**	**15.84**	**16.10**	**17.78**	**16.72**	**0.91**
Vanadium						
Deconsolidation-leach (DRF-26A) (µg):	34.65	33.11	34.10	34.35		
Burn-leach (DRF-26B) (µg):	33.89	34.30	30.77	34.00		
Total leached (µg):	68.54	67.41	64.87	68.35		
V outside SiC (µg/compact):	**22.85**	**22.47**	**21.62**	**22.78**	**22.43**	**0.56**
Titanium and Vanadium						
Ti + V outside SiC (µg/compact):	**40.02**	**38.31**	**37.72**	**40.56**	**39.15**	**1.35**

QC Supervisor

8-21-06
Date

Inspection Report Form IRF-05C: Summary of Uranium Contamination

Procedure:	AGR-CHAR-PIP-05 Rev. 0
Operator:	Fred Montgomery
Compact lot ID:	LEU01-49T-Z
Compact Lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T

Compact ID numbers:	22, 57, 74	51, 53, 71	15, 40, 48	11, 31, 35	6, 8, 10, 13, 55, 78	7, 32, 45, 47, 56, 75	Total
Number of compacts:	3	3	3	3	6	6	24
Effective number of exposed kernels:	0.0	0.0	0.0	0.0	0.0	0.0	0.0

QC Supervisor

8-21-06
Date

Inspection Report Form IRF-05D: Summary of SiC Burn-Leach Defects

Procedure:	AGR-CHAR-PIP-05 Rev. 0
Operator:	Fred Montgomery
Compact lot ID:	LEU01-49T-Z
Compact Lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T

Compact ID numbers:	22, 57, 74	51, 53, 71	15, 40, 48	11, 31, 35			Total
Number of compacts:	3	3	3	3			12
Number of leached kernels:	0	0	0	0			0

QC Supervisor

8-21-06
Date

Data Report Form DRF-24: Compact Diameter and Length

Procedure:	AGR-CHAR-DAM-24 Rev. 3
Operator:	Ivan Dunbar
Compact lot ID:	LEU01-49T-Z
Compact Lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T
Filename:	\\mc-agr\AGR\CompactDimensions\LEU01-49T-Z_DRF24R3.xls

Vertical height gauge calibration due date:	9/8/06
Pass-thru block calibration due date:	1/17/09
Digital caliper calibration due date:	9/8/06
Gauge blocks calibration due date:	9/8/06

Acceptance criteria for compact length:	≥25.02 and ≤25.40 mm
Acceptance criteria for compact diameter:	≥12.22 and ≤12.46 mm (and pass through 12.46 mm ring gauge)
Acceptance criteria for compact mass:	For information only

Compact ID Number	Length (mm)	Diameter (mm)						Pass Thru? (Y or N)	Mass (g)	Accept? (pass or fail)
		Top 1	Top 2	Middle 1	Middle 2	Bottom 1	Bottom 2			
01	25.236	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5957	pass
02	25.231	12.34	12.34	12.34	12.34	12.33	12.34	Y	5.5719	pass
03	25.242	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5973	pass
04	25.233	12.34	12.34	12.34	12.34	12.32	12.32	Y	5.5885	pass
05	25.218	12.34	12.34	12.34	12.34	12.32	12.32	Y	5.5582	pass
06	25.228	12.35	12.34	12.34	12.34	12.32	12.32	Y	5.5895	pass
07	25.201	12.34	12.34	12.34	12.34	12.32	12.32	Y	5.5776	pass
08	25.204	12.34	12.35	12.35	12.35	12.33	12.33	Y	5.6065	pass
09	25.233	12.34	12.34	12.34	12.34	12.32	12.32	Y	5.5803	pass
10	25.118	12.34	12.34	12.34	12.34	12.33	12.32	Y	5.5511	pass
11	25.306	12.34	12.34	12.34	12.34	12.32	12.33	Y	5.5630	pass
12	25.171	12.34	12.34	12.33	12.34	12.33	12.32	Y	5.5587	pass
13	25.198	12.34	12.34	12.35	12.34	12.33	12.32	Y	5.5973	pass
14	25.182	12.34	12.34	12.35	12.34	12.34	12.33	Y	5.6120	pass
15	25.257	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.6102	pass
16	25.245	12.34	12.34	12.35	12.35	12.34	12.33	Y	5.6286	pass
17	25.187	12.34	12.34	12.35	12.35	12.33	12.33	Y	5.6082	pass
18	25.173	12.34	12.34	12.34	12.34	12.33	12.32	Y	5.5962	pass
19	25.224	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.6048	pass
20	25.256	12.35	12.35	12.34	12.34	12.33	12.33	Y	5.5825	pass
21	25.163	12.34	12.34	12.35	12.35	12.33	12.32	Y	5.5620	pass
22	25.194	12.33	12.33	12.34	12.34	12.33	12.33	Y	5.5774	pass
23	25.219	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5659	pass
24	25.289	12.34	12.34	12.35	12.34	12.33	12.33	Y	5.5936	pass
25	25.259	12.34	12.34	12.34	12.34	12.33	12.32	Y	5.6068	pass
26	25.208	12.34	12.34	12.34	12.34	12.32	12.33	Y	5.5768	pass
27	25.304	12.34	12.34	12.35	12.34	12.33	12.33	Y	5.6112	pass
28	25.224	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.6060	pass
29	25.246	12.34	12.34	12.34	12.34	12.32	12.33	Y	5.5894	pass
30	25.255	12.35	12.34	12.33	12.34	12.33	12.33	Y	5.5886	pass
31	25.256	12.34	12.34	12.34	12.35	12.33	12.33	Y	5.6182	pass
32	25.179	12.34	12.34	12.34	12.35	12.33	12.32	Y	5.5836	pass
33	25.203	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5597	pass
34	25.203	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5624	pass
35	25.168	12.34	12.34	12.34	12.34	12.33	12.32	Y	5.6089	pass
36	25.253	12.35	12.34	12.34	12.35	12.33	12.33	Y	5.6065	pass
37	25.215	12.34	12.34	12.34	12.34	12.33	12.32	Y	5.5649	pass
38	25.219	12.34	12.34	12.33	12.34	12.33	12.33	Y	5.5573	pass
39	25.232	12.34	12.34	12.34	12.34	12.33	12.32	Y	5.5829	pass
40	25.195	12.34	12.34	12.35	12.34	12.32	12.33	Y	5.5781	pass

Comments

Page 1 of 2
For diameter measurement, top corresponds to compact end at top during pressing.
Top end cap appears shinier than bottom.

Operator

6-23-06
Date

QC Supervisor

6-23-06
Date

J. S. Ray for M. C. Vance
QA Reviewer

6/23/06
Date

Data Report Form DRF-24: Compact Diameter and Length

Procedure:	AGR-CHAR-DAM-24 Rev. 3
Operator:	Ivan Dunbar
Compact lot ID:	LEU01-49T-Z
Compact Lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T
Filename:	\\mc-agr\AGR\CompactDimensions\LEU01-49T-Z_DRF24R3.xls

Vertical height gauge calibration due date:	9/8/06
Pass-thru block calibration due date:	1/17/09
Digital caliper calibration due date:	9/8/06
Gauge blocks calibration due date:	9/8/06

Acceptance criteria for compact length:	≥25.02 and ≤25.40 mm
Acceptance criteria for compact diameter:	≥12.22 and ≤12.46 mm (and pass through 12.46 mm ring gauge)
Acceptance criteria for compact mass:	For information only

Compact ID Number	Length (mm)	Diameter (mm)						Pass Thru? (Y or N)	Mass (g)	Accept? (pass or fail)
		Top 1	Top 2	Middle 1	Middle 2	Bottom 1	Bottom 2			
41	25.274	12.34	12.34	12.34	12.34	12.32	12.33	Y	5.5729	pass
42	25.224	12.34	12.34	12.35	12.34	12.33	12.33	Y	5.6149	pass
43	25.182	12.35	12.35	12.34	12.34	12.33	12.33	Y	5.5659	pass
44	25.172	12.34	12.33	12.34	12.34	12.33	12.33	Y	5.5681	pass
45	25.251	12.34	12.34	12.34	12.35	12.33	12.33	Y	5.5835	pass
46	25.302	12.35	12.34	12.34	12.34	12.32	12.33	Y	5.5974	pass
47	25.200	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5657	pass
48	25.218	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5890	pass
49	25.233	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5874	pass
50	25.255	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5829	pass
51	25.192	12.34	12.34	12.34	12.34	12.32	12.33	Y	5.5995	pass
52	25.161	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5794	pass
53	25.185	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5715	pass
54	25.252	12.34	12.35	12.35	12.35	12.34	12.34	Y	5.6898	pass
55	25.176	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5794	pass
56	25.213	12.34	12.34	12.35	12.34	12.33	12.33	Y	5.5768	pass
57	25.179	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5578	pass
58	25.253	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.6177	pass
59	25.125	12.35	12.34	12.35	12.35	12.33	12.32	Y	5.5644	pass
60	25.209	12.33	12.34	12.34	12.34	12.32	12.33	Y	5.5516	pass
61	25.161	12.34	12.34	12.34	12.34	12.31	12.31	Y	5.5779	pass
62	25.199	12.34	12.34	12.34	12.34	12.31	12.33	Y	5.5709	pass
63	25.266	12.34	12.34	12.35	12.34	12.33	12.32	Y	5.5966	pass
64	25.218	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5716	pass
65	25.231	12.35	12.34	12.34	12.34	12.32	12.32	Y	5.6062	pass
66	25.236	12.35	12.34	12.34	12.34	12.33	12.33	Y	5.5605	pass
67	25.126	12.34	12.34	12.34	12.34	12.32	12.32	Y	5.5623	pass
68	25.232	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.6026	pass
69	25.187	12.34	12.34	12.34	12.34	12.34	12.34	Y	5.6003	pass
70	25.228	12.34	12.34	12.34	12.34	12.32	12.33	Y	5.5748	pass
71	25.247	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5699	pass
72	25.233	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5839	pass
73	25.192	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5979	pass
74	25.191	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5910	pass
75	25.161	12.34	12.35	12.34	12.34	12.33	12.33	Y	5.5991	pass
76	25.165	12.34	12.34	12.34	12.34	12.33	12.33	Y	5.5945	pass
77	25.298	12.34	12.34	12.34	12.34	12.34	12.33	Y	5.6297	pass
78	25.266	12.34	12.33	12.34	12.34	12.32	12.33	Y	5.5879	pass
79	25.208	12.34	12.34	12.34	12.35	12.32	12.33	Y	5.6035	pass

Comments

Page 2 of 2
For diameter measurement, top corresponds to compact end at top during pressing.
Top end cap appears shinier than bottom.

Operator

6-23-06
Date

QC Supervisor

6-23-06
Date

J.S. Ogg for M.C. Vance
QA Reviewer

6/23/06
Date

Data Report Form DRF-25: Fuel Compact Mean Uranium Loading

Procedure:	AGR-CHAR-DAM-25 Rev. 1
Operator:	Montgomery
Compact lot ID:	LEU01-49T-Z
Compact lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T
Filename:	\\mc-agr\AGR\UraniumLoading\LEU01-49T-Z_DRF25R1.xls

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
Compact ID number:	12	23	26	42	50	63
Sample tube ID number:	U0606270101	U060627201	U060627301	U060627401	U060627501	U060627601
Radiochemical laboratory analysis number:	060629-023	060629-024	060629-025	060629-026	060629-027	060629-028
Measured U in compact (g):	0.910	0.912	0.909	0.916	0.912	0.912
Uncertainty in measured U in compact (g):	0.001	0.001	0.001	0.001	0.001	0.001

Mean uranium loading (gU/compact):	0.912
Standard deviation in mean uranium loading (gU/compact):	0.002

Comments
FCM checked against official data 6/30/2006

Fred C. Montgomery
Operator

6/30/2006
Date

Data Report Form DRF-26A: Measurement of U Contamination and Impurities by Deconsolidation Leach

Procedure:	AGR-CHAR-DAM-26 Rev. 0
Operator:	Fred Montgomery
Compact lot ID:	LEU01-49T-Z
Compact lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T
Compact ID numbers:	22, 57, 74
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\LEU01-49T-Z_DRF26R0.xls

Mean average weight/kernel (g):	2.42E-04
Uncertainty in mean average weight/kernel (g):	5.96E-07
Mean weight % uranium/kernel:	90.06
Standard deviation in weight % uranium/kernel:	0.09
Approximate weight uranium/kernel (g):	2.18E-04
Uncertainty in approx. weight uranium/kernel (g):	5.76E-07

	First Leach	Second Leach	Total
Deconsolidation-leach solution ID:	L0607140301	L0607140402	
Number of compacts:	3		
Volume of leach solution (ml):			
Measured β activity of 0.1ml aliquot (dpm):			
Estimated weight of U in leach solution (mg):			
Radiochemical laboratory analysis number:	060724-070	060724-071	
Weight uranium leached (g):	3.71E-07	1.73E-08	3.88E-07
Uncertainty in weight uranium leached (g):	3.70E-08	1.70E-09	3.70E-08
Effective number of exposed kernels:	0.0	0.0	0.0
Uncertainty in effective number of exposed kernels:	0.0	0.0	0.0
Fe content of leach solution (μg):	3.02	0.852	3.87
Uncertainty in measured Fe content (μg):	0.60	0.17	0.62
Cr content of leach solution (μg):	0.329	< 0.063	0.39
Uncertainty in measured Cr content (μg):	0.033		0.03
Mn content of leach solution (μg):	0.108	< 0.063	0.17
Uncertainty in measured Mn content (μg):	0.022		0.02
Co content of leach solution (μg):	< 0.063	< 0.063	0.13
Uncertainty in measured Co content (μg):			
Ni content of leach solution (μg):	1.13	0.361	1.49
Uncertainty in measured Ni content (μg):	0.11	0.036	0.12
Ca content of leach solution (μg):	20.60	14.40	35.00
Uncertainty in measured Ca content (μg):	4.10	2.90	5.02
Al content of leach solution (μg):	12.20	8.71	20.91
Uncertainty in measured Al content (μg):	1.20	0.87	1.48
Ti content of leach solution (μg):	32.80	3.02	35.82
Uncertainty in measured Ti content (μg):	3.30	0.30	3.31
V content of leach solution (μg):	31.90	2.75	34.65
Uncertainty in measured V content (μg):	3.20	0.28	3.21

Comments

Data by ICPMS Procedure CSDSW846-6020
Checked by FCM 8/18/2006 against official results of analysis for IPA14367

Fred C. Montgomery
Operator

8-21-06
Date

Data Report Form DRF-26A: Measurement of U Contamination and Impurities by Deconsolidation Leach

Procedure:	AGR-CHAR-DAM-26 Rev. 0
Operator:	Fred Montgomery
Compact lot ID:	LEU01-49T-Z
Compact lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T
Compact ID numbers:	51, 53, 71
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\LEU01-49T-Z_DRF26R0.xls

Mean average weight/kernel (g):	2.42E-04
Uncertainty in mean average weight/kernel (g):	5.96E-07
Mean weight % uranium/kernel:	90.06
Standard deviation in weight % uranium/kernel:	0.09
Approximate weight uranium/kernel (g):	2.18E-04
Uncertainty in approx. weight uranium/kernel (g):	5.76E-07

	First Leach	Second Leach	Total
Deconsolidation-leach solution ID:	L0607140501	L0607140602	
Number of compacts:	3		
Volume of leach solution (ml):			
Measured β activity of 0.1ml aliquot (dpm):			
Estimated weight of U in leach solution (mg):			
Radiochemical laboratory analysis number:	060724-072	060724-073	
Weight uranium leached (g):	3.46E-07	2.11E-08	3.67E-07
Uncertainty in weight uranium leached (g):	3.50E-08	2.10E-09	3.51E-08
Effective number of exposed kernels:	0.0	0.0	0.0
Uncertainty in effective number of exposed kernels:	0.0	0.0	0.0
Fe content of leach solution (µg):	1.86	1.16	3.02
Uncertainty in measured Fe content (µg):	0.37	0.23	0.44
Cr content of leach solution (µg):	0.316	0.113	0.43
Uncertainty in measured Cr content (µg):	0.032	0.023	0.04
Mn content of leach solution (µg):	< 0.063	< 0.06	0.12
Uncertainty in measured Mn content (µg):			
Co content of leach solution (µg):	< 0.063	< 0.06	0.12
Uncertainty in measured Co content (µg):			
Ni content of leach solution (µg):	0.659	0.255	0.91
Uncertainty in measured Ni content (µg):	0.066	0.051	0.08
Ca content of leach solution (µg):	23.50	17.70	41.20
Uncertainty in measured Ca content (µg):	4.70	3.50	5.86
Al content of leach solution (µg):	10.80	11.80	22.60
Uncertainty in measured Al content (µg):	1.10	1.20	1.63
Ti content of leach solution (µg):	26.10	3.31	29.41
Uncertainty in measured Ti content (µg):	2.60	0.33	2.62
V content of leach solution (µg):	30.60	2.51	33.11
Uncertainty in measured V content (µg):	3.10	0.25	3.11

Comments

Data by ICPMS Procedure CSDSW846-6020
Checked by FCM 8/18/2006 against official results of analysis for IPA14367

Fred C. Montgomery
Operator

8-21-06
Date

Data Report Form DRF-26A: Measurement of U Contamination and Impurities by Deconsolidation Leach

Procedure:	AGR-CHAR-DAM-26 Rev. 0
Operator:	Fred Montgomery
Compact lot ID:	LEU01-49T-Z
Compact lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T
Compact ID numbers:	15, 40, 48
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\LEU01-49T-Z_DRF26R0.xls

Mean average weight/kernel (g):	2.42E-04
Uncertainty in mean average weight/kernel (g):	5.96E-07
Mean weight % uranium/kernel:	90.06
Standard deviation in weight % uranium/kernel:	0.09
Approximate weight uranium/kernel (g):	2.18E-04
Uncertainty in approx. weight uranium/kernel (g):	5.76E-07

	First Leach	Second Leach	Total
Deconsolidation-leach solution ID:	L0607140701	L0607140802	
Number of compacts:	3		
Volume of leach solution (ml):			
Measured β activity of 0.1ml aliquot (dpm):			
Estimated weight of U in leach solution (mg):			
Radiochemical laboratory analysis number:	060724-074	060724-075	
Weight uranium leached (g):	3.46E-07	1.78E-08	3.64E-07
Uncertainty in weight uranium leached (g):	3.50E-08	1.80E-09	3.50E-08
Effective number of exposed kernels:	0.0	0.0	0.0
Uncertainty in effective number of exposed kernels:	0.0	0.0	0.0
Fe content of leach solution (µg):	3.24	1.01	4.25
Uncertainty in measured Fe content (µg):	0.65	0.20	0.68
Cr content of leach solution (µg):	0.37	0.073	0.44
Uncertainty in measured Cr content (µg):	0.037	0.015	0.04
Mn content of leach solution (µg):	0.069	< 0.063	0.13
Uncertainty in measured Mn content (µg):	0.014		0.01
Co content of leach solution (µg):	< 0.065	< 0.063	0.13
Uncertainty in measured Co content (µg):			
Ni content of leach solution (µg):	0.659	0.185	0.84
Uncertainty in measured Ni content (µg):	0.066	0.037	0.08
Ca content of leach solution (µg):	19.40	13.10	32.50
Uncertainty in measured Ca content (µg):	3.90	2.60	4.69
Al content of leach solution (µg):	11.30	6.96	18.26
Uncertainty in measured Al content (µg):	1.10	0.70	1.30
Ti content of leach solution (µg):	27.70	2.62	30.32
Uncertainty in measured Ti content (µg):	2.80	0.26	2.81
V content of leach solution (µg):	31.30	2.80	34.10
Uncertainty in measured V content (µg):	3.10	0.28	3.11

Comments

Data by ICPMS Procedure CSDSW846-6020
Checked by FCM 8/18/2006 against official results of analysis for IPA14367

Fred C. Montgomery
Operator

8-21-06
Date

Data Report Form DRF-26A: Measurement of U Contamination and Impurities by Deconsolidation Leach

Procedure:	AGR-CHAR-DAM-26 Rev. 0
Operator:	Fred Montgomery
Compact lot ID:	LEU01-49T-Z
Compact lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T
Compact ID numbers:	11, 31, 35
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\LEU01-49T-Z_DRF26R0.xls

Mean average weight/kernel (g):	2.42E-04
Uncertainty in mean average weight/kernel (g):	5.96E-07
Mean weight % uranium/kernel:	90.06
Standard deviation in weight % uranium/kernel:	0.09
Approximate weight uranium/kernel (g):	2.18E-04
Uncertainty in approx. weight uranium/kernel (g):	5.76E-07

	First Leach	Second Leach	Total
Deconsolidation-leach solution ID:	L0607140901	L0607141002	
Number of compacts:	3		
Volume of leach solution (ml):			
Measured β activity of 0.1ml aliquot (dpm):			
Estimated weight of U in leach solution (mg):			
Radiochemical laboratory analysis number:	060724-076	060724-077	
Weight uranium leached (g):	2.96E-07	1.32E-08	3.09E-07
Uncertainty in weight uranium leached (g):	3.00E-08	1.30E-09	3.00E-08
Effective number of exposed kernels:	0.0	0.0	0.0
Uncertainty in effective number of exposed kernels:	0.0	0.0	0.0
Fe content of leach solution (µg):	2.63	6.00	8.63
Uncertainty in measured Fe content (µg):	0.52	0.60	0.79
Cr content of leach solution (µg):	0.274	0.383	0.66
Uncertainty in measured Cr content (µg):	0.055	0.038	0.07
Mn content of leach solution (µg):	< 0.061	0.121	0.18
Uncertainty in measured Mn content (µg):		0.024	0.02
Co content of leach solution (µg):	< 0.061	< 0.059	0.12
Uncertainty in measured Co content (µg):			
Ni content of leach solution (µg):	0.657	0.304	0.96
Uncertainty in measured Ni content (µg):	0.066	0.03	0.07
Ca content of leach solution (µg):	33.50	15.50	49.00
Uncertainty in measured Ca content (µg):	6.70	3.10	7.38
Al content of leach solution (µg):	12.30	9.22	21.52
Uncertainty in measured Al content (µg):	1.20	0.92	1.51
Ti content of leach solution (µg):	31.70	3.88	35.58
Uncertainty in measured Ti content (µg):	3.20	0.39	3.22
V content of leach solution (µg):	31.30	3.05	34.35
Uncertainty in measured V content (µg):	3.10	0.30	3.11

Comments

Data by ICPMS Procedure CSDSW846-6020
Checked by FCM 8/18/2006 against official results of analysis for IPA14367

Fred C. Montgomery
Operator

8-21-06
Date

Data Report Form DRF-26A: Measurement of U Contamination and Impurities by Deconsolidation Leach

Procedure:	AGR-CHAR-DAM-26 Rev. 0
Operator:	Fred Montgomery
Compact lot ID:	LEU01-49T-Z
Compact lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T
Compact ID numbers:	6, 8, 10, 13, 55, 78
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\LEU01-49T-Z_DRF26R0.xls

Mean average weight/kernel (g):	2.42E-04
Uncertainty in mean average weight/kernel (g):	5.96E-07
Mean weight % uranium/kernel:	90.06
Standard deviation in weight % uranium/kernel:	0.09
Approximate weight uranium/kernel (g):	2.18E-04
Uncertainty in approx. weight uranium/kernel (g):	5.76E-07

	First Leach	Second Leach	Total
Deconsolidation-leach solution ID:	L0607310101	L0608020102	
Number of compacts:	6		
Volume of leach solution (ml):			
Measured β activity of 0.1ml aliquot (dpm):			
Estimated weight of U in leach solution (mg):			
Radiochemical laboratory analysis number:	060804-022	060804-024	
Weight uranium leached (g):	6.62E-07	2.18E-08	6.84E-07
Uncertainty in weight uranium leached (g):	6.60E-08	2.20E-09	6.60E-08
Effective number of exposed kernels:	0.0	0.0	0.0
Uncertainty in effective number of exposed kernels:	0.0	0.0	0.0
Fe content of leach solution (µg):	12.20	3.02	15.22
Uncertainty in measured Fe content (µg):	1.20	0.60	1.34
Cr content of leach solution (µg):	0.70	0.20	0.90
Uncertainty in measured Cr content (µg):	0.07	0.04	0.08
Mn content of leach solution (µg):	0.12	0.10	0.22
Uncertainty in measured Mn content (µg):	0.02	0.02	0.03
Co content of leach solution (µg):	< 0.10	< 0.09	0.19
Uncertainty in measured Co content (µg):			
Ni content of leach solution (µg):	1.17	0.36	1.53
Uncertainty in measured Ni content (µg):	0.12	0.07	0.14
Ca content of leach solution (µg):	27.90	23.00	50.90
Uncertainty in measured Ca content (µg):	5.60	4.60	7.25
Al content of leach solution (µg):	14.20	9.36	23.56
Uncertainty in measured Al content (µg):	1.40	1.90	2.36
Ti content of leach solution (µg):	50.90	7.72	58.62
Uncertainty in measured Ti content (µg):	5.10	0.77	5.16
V content of leach solution (µg):	62.90	4.49	67.39
Uncertainty in measured V content (µg):	6.30	0.45	6.32

Comments

Data by ICPMS Procedure CSDSW846-6020
Checked by FCM 8/18/2006 against official results of analysis for IPA14391

Fred C. Montgomery
Operator

8-21-06
Date

Data Report Form DRF-26A: Measurement of U Contamination and Impurities by Deconsolidation Leach

Procedure:	AGR-CHAR-DAM-26 Rev. 0
Operator:	Fred Montgomery
Compact lot ID:	LEU01-49T-Z
Compact lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T
Compact ID numbers:	7, 32, 45, 47, 56, 75
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\LEU01-49T-Z_DRF26R0.xls

Mean average weight/kernel (g):	2.42E-04
Uncertainty in mean average weight/kernel (g):	5.96E-07
Mean weight % uranium/kernel:	90.06
Standard deviation in weight % uranium/kernel:	0.09
Approximate weight uranium/kernel (g):	2.18E-04
Uncertainty in approx. weight uranium/kernel (g):	5.76E-07

	First Leach	Second Leach	Total
Deconsolidation-leach solution ID:	L0607310201	L0608020202	
Number of compacts:	6		
Volume of leach solution (ml):			
Measured β activity of 0.1ml aliquot (dpm):			
Estimated weight of U in leach solution (mg):			
Radiochemical laboratory analysis number:	060804-023	060804-025	
Weight uranium leached (g):	6.24E-07	2.14E-08	6.45E-07
Uncertainty in weight uranium leached (g):	6.20E-08	2.10E-09	6.20E-08
Effective number of exposed kernels:	0.0	0.0	0.0
Uncertainty in effective number of exposed kernels:	0.0	0.0	0.0
Fe content of leach solution (µg):	2.93	2.20	5.13
Uncertainty in measured Fe content (µg):	0.59	0.44	0.74
Cr content of leach solution (µg):	0.54	0.17	0.71
Uncertainty in measured Cr content (µg):	0.05	0.03	0.06
Mn content of leach solution (µg):	0.17	< 0.09	0.26
Uncertainty in measured Mn content (µg):	0.03		0.03
Co content of leach solution (µg):	< 0.10	< 0.09	0.19
Uncertainty in measured Co content (µg):			
Ni content of leach solution (µg):	1.85	1.50	3.35
Uncertainty in measured Ni content (µg):	0.19	0.15	0.24
Ca content of leach solution (µg):	34.70	24.70	59.40
Uncertainty in measured Ca content (µg):	6.90	4.90	8.46
Al content of leach solution (µg):	15.40	7.55	22.95
Uncertainty in measured Al content (µg):	1.50	1.50	2.12
Ti content of leach solution (µg):	54.20	7.50	61.70
Uncertainty in measured Ti content (µg):	5.40	0.75	5.45
V content of leach solution (µg):	65.60	4.85	70.45
Uncertainty in measured V content (µg):	6.60	0.49	6.62

Comments

Data by ICPMS Procedure CSDSW846-6020
Checked by FCM 8/18/2006 against official results of analysis for IPA14391

Fred C. Montgomery
Operator

8-21-06
Date

Data Report Form DRF-26B: Measurement of SiC Burn-Leach Defects and Impurities by Burn-Leach

Procedure:	AGR-CHAR-DAM-26 Rev. 0
Operator:	Fred Montgomery
Compact lot ID:	LEU01-49T-Z
Compact lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T
Compact ID numbers:	22, 57, 74
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\LEU01-49T-Z_DRF26R0.xls

Mean average weight/kernel (g):	2.42E-04
Uncertainty in mean average weight/kernel (g):	5.96E-07
Mean weight % uranium/kernel:	90.06
Standard deviation in weight % uranium/kernel:	0.09
Approximate weight uranium/kernel (g):	2.18E-04
Uncertainty in approx. weight uranium/kernel (g):	5.76E-07

	First Leach	Second Leach	Total
Burn-leach solution ID:	B0607250201	B0607270202	
Number of compacts:	3		
Volume of leach solution (ml):			
Measured β activity of 0.1ml aliquot (dpm):			
Estimated weight of U in leach solution (mg):			
Radiochemical laboratory analysis number:	060804-011	060804-017	
Weight uranium leached (g):	8.55E-08	2.05E-09	8.76E-08
Uncertainty in weight uranium leached (g):	8.60E-09	2.10E-10	8.60E-09
Number of leached kernels:	0.0	0.0	0.0
Uncertainty in number of leached kernels:	0.0	0.0	0.0
Fe content of leach solution (µg):	13.20	0.855	14.06
Uncertainty in measured Fe content (µg):	1.30	0.17	1.31
Cr content of leach solution (µg):	0.295	< 0.025	0.32
Uncertainty in measured Cr content (µg):	0.03		0.03
Mn content of leach solution (µg):	0.139	< 0.025	0.16
Uncertainty in measured Mn content (µg):	0.014		0.01
Co content of leach solution (µg):	< 0.025	< 0.025	0.05
Uncertainty in measured Co content (µg):			
Ni content of leach solution (µg):	2.90	0.08	2.98
Uncertainty in measured Ni content (µg):	0.29	0.016	0.29
Ca content of leach solution (µg):	20.10	5.90	26.00
Uncertainty in measured Ca content (µg):	4.00	1.20	4.18
Al content of leach solution (µg):	8.72	0.594	9.31
Uncertainty in measured Al content (µg):	0.87	0.12	0.88
Ti content of leach solution (µg):	13.70	1.99	15.69
Uncertainty in measured Ti content (µg):	1.40	0.20	1.41
V content of leach solution (µg):	33.20	0.692	33.89
Uncertainty in measured V content (µg):	3.30	0.069	3.30

Comments

Data by ICPMS Procedure CSDSW846-6020
Checked by FCM 8/18/2006 against official results of analysis for IPA14391

Fred C. Montgomery
Operator

8-21-06
Date

Data Report Form DRF-26B: Measurement of SiC Burn-Leach Defects and Impurities by Burn-Leach

Procedure:	AGR-CHAR-DAM-26 Rev. 0
Operator:	Fred Montgomery
Compact lot ID:	LEU01-49T-Z
Compact lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T
Compact ID numbers:	51, 53, 71
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\LEU01-49T-Z_DRF26R0.xls

Mean average weight/kernel (g):	2.42E-04
Uncertainty in mean average weight/kernel (g):	5.96E-07
Mean weight % uranium/kernel:	90.06
Standard deviation in weight % uranium/kernel:	0.09
Approximate weight uranium/kernel (g):	2.18E-04
Uncertainty in approx. weight uranium/kernel (g):	5.76E-07

	First Leach	Second Leach	Total
Burn-leach solution ID:	B0607250301	B0607270302	
Number of compacts:	3		
Volume of leach solution (ml):			
Measured β activity of 0.1ml aliquot (dpm):			
Estimated weight of U in leach solution (mg):			
Radiochemical laboratory analysis number:	060804-012	060804-018	
Weight uranium leached (g):	8.12E-08	6.50E-10	8.19E-08
Uncertainty in weight uranium leached (g):	8.10E-09	6.50E-11	8.10E-09
Number of leached kernels:	0.0	0.0	0.0
Uncertainty in number of leached kernels:	0.0	0.0	0.0
Fe content of leach solution (µg):	2.39	0.609	3.00
Uncertainty in measured Fe content (µg):	0.24	0.12	0.27
Cr content of leach solution (µg):	0.323	< 0.025	0.35
Uncertainty in measured Cr content (µg):	0.032		0.03
Mn content of leach solution (µg):	0.028	< 0.025	0.05
Uncertainty in measured Mn content (µg):	0.006		0.01
Co content of leach solution (µg):	< 0.025	< 0.025	0.05
Uncertainty in measured Co content (µg):			
Ni content of leach solution (µg):	2.76	0.086	2.85
Uncertainty in measured Ni content (µg):	0.28	0.017	0.28
Ca content of leach solution (µg):	18.40	< 5.00	23.40
Uncertainty in measured Ca content (µg):	3.70		3.70
Al content of leach solution (µg):	9.55	0.759	10.31
Uncertainty in measured Al content (µg):	0.96	0.15	0.97
Ti content of leach solution (µg):	17.70	0.405	18.11
Uncertainty in measured Ti content (µg):	1.80	0.04	1.80
V content of leach solution (µg):	34.00	0.301	34.30
Uncertainty in measured V content (µg):	3.40	0.03	3.40

Comments

Data by ICPMS Procedure CSDSW846-6020
Checked by FCM 8/18/2006 against official results of analysis for IPA14391

Fred C. Montgomery
Operator

8-21-06
Date

Data Report Form DRF-26B: Measurement of SiC Burn-Leach Defects and Impurities by Burn-Leach

Procedure:	AGR-CHAR-DAM-26 Rev. 0
Operator:	Fred Montgomery
Compact lot ID:	LEU01-49T-Z
Compact lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T
Compact ID numbers:	15, 40, 48
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\LEU01-49T-Z_DRF26R0.xls

Mean average weight/kernel (g):	2.42E-04
Uncertainty in mean average weight/kernel (g):	5.96E-07
Mean weight % uranium/kernel:	90.06
Standard deviation in weight % uranium/kernel:	0.09
Approximate weight uranium/kernel (g):	2.18E-04
Uncertainty in approx. weight uranium/kernel (g):	5.76E-07

	First Leach	Second Leach	Total
Burn-leach solution ID:	B0607250401	B0607270402	
Number of compacts:	3		
Volume of leach solution (ml):			
Measured β activity of 0.1ml aliquot (dpm):			
Estimated weight of U in leach solution (mg):			
Radiochemical laboratory analysis number:	060804-013	060804-019	
Weight uranium leached (g):	8.41E-08	1.40E-09	8.55E-08
Uncertainty in weight uranium leached (g):	8.40E-09	1.40E-10	8.40E-09
Number of leached kernels:	0.0	0.0	0.0
Uncertainty in number of leached kernels:	0.0	0.0	0.0
Fe content of leach solution (µg):	3.62	1.53	5.15
Uncertainty in measured Fe content (µg):	0.36	0.15	0.39
Cr content of leach solution (µg):	0.335	0.03	0.36
Uncertainty in measured Cr content (µg):	0.033	0.006	0.03
Mn content of leach solution (µg):	0.05	< 0.025	0.08
Uncertainty in measured Mn content (µg):	0.01		0.01
Co content of leach solution (µg):	< 0.025	< 0.025	0.05
Uncertainty in measured Co content (µg):			
Ni content of leach solution (µg):	3.28	0.797	4.08
Uncertainty in measured Ni content (µg):	0.33	0.08	0.34
Ca content of leach solution (µg):	21.10	6.52	27.62
Uncertainty in measured Ca content (µg):	4.20	1.30	4.40
Al content of leach solution (µg):	8.36	1.01	9.37
Uncertainty in measured Al content (µg):	0.84	0.20	0.86
Ti content of leach solution (µg):	17.70	0.281	17.98
Uncertainty in measured Ti content (µg):	1.80	0.028	1.80
V content of leach solution (µg):	30.40	0.366	30.77
Uncertainty in measured V content (µg):	3.00	0.037	3.00

Comments

Data by ICPMS Procedure CSDSW846-6020
Checked by FCM 8/18/2006 against official results of analysis for IPA14391

Fred C. Montgomery
Operator

8-21-06
Date

Data Report Form DRF-26B: Measurement of SiC Burn-Leach Defects and Impurities by Burn-Leach

Procedure:	AGR-CHAR-DAM-26 Rev. 0
Operator:	Fred Montgomery
Compact lot ID:	LEU01-49T-Z
Compact lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T
Compact ID numbers:	11, 31, 35
DRF filename:	\\mc-agr\AGR\LeachBurnLeach\LEU01-49T-Z_DRF26R0.xls

Mean average weight/kernel (g):	2.42E-04
Uncertainty in mean average weight/kernel (g):	5.96E-07
Mean weight % uranium/kernel:	90.06
Standard deviation in weight % uranium/kernel:	0.09
Approximate weight uranium/kernel (g):	2.18E-04
Uncertainty in approx. weight uranium/kernel (g):	5.76E-07

	First Leach	Second Leach	Total
Burn-leach solution ID:	B0607250501	B0607270502	
Number of compacts:	3		
Volume of leach solution (ml):			
Measured β activity of 0.1ml aliquot (dpm):			
Estimated weight of U in leach solution (mg):			
Radiochemical laboratory analysis number:	060804-014	060804-020	
Weight uranium leached (g):	8.58E-08	1.95E-09	8.78E-08
Uncertainty in weight uranium leached (g):	8.60E-09	2.00E-10	8.60E-09
Number of leached kernels:	0.0	0.0	0.0
Uncertainty in number of leached kernels:	0.0	0.0	0.0
Fe content of leach solution (μg):	2.02	0.695	2.72
Uncertainty in measured Fe content (μg):	0.20	0.14	0.24
Cr content of leach solution (μg):	0.332	0.036	0.37
Uncertainty in measured Cr content (μg):	0.033	0.007	0.03
Mn content of leach solution (μg):	< 0.025	< 0.025	0.05
Uncertainty in measured Mn content (μg):			
Co content of leach solution (μg):	< 0.025	< 0.025	0.05
Uncertainty in measured Co content (μg):			
Ni content of leach solution (μg):	2.25	0.083	2.33
Uncertainty in measured Ni content (μg):	0.22	0.017	0.22
Ca content of leach solution (μg):	19.70	5.82	25.52
Uncertainty in measured Ca content (μg):	3.90	1.20	4.08
Al content of leach solution (μg):	8.98	2.00	10.98
Uncertainty in measured Al content (μg):	0.90	0.40	0.98
Ti content of leach solution (μg):	12.60	5.16	17.76
Uncertainty in measured Ti content (μg):	1.30	0.52	1.40
V content of leach solution (μg):	32.70	1.30	34.00
Uncertainty in measured V content (μg):	3.30	0.13	3.30

Comments

Data by ICPMS Procedure CSDSW846-6020
Checked by FCM 8/18/2006 against official results of analysis for IPA14391

Fred C. Montgomery — Operator

8-21-06 — Date

Data Report Form DRF-27: Counting of Particles with a Defective OPyC Layer from Deconsolidated Compacts by Visual Inspection

Procedure:	AGR-CHAR-DAM-27 Rev. 0
Operator:	Fred Montgomery
Compact lot ID:	LEU01-49T-Z
Compact lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T
Compact ID number:	70
DRF filename:	\\mc-agr\AGR\DefectiveOPyC\LEU01-49T-Z_DRF27R0.xls

Number of particles with cracked OPyC:	0
Number of particles with partially missing OPyC:	0
Number of particles with completely missing OPyC:	0
Total number of particles with defective OPyC:	0

Comments on unusual visual characteristics of OPyC

Fred C. Montgomery
Operator

8/21/06
Date

Data Report Form DRF-28: Counting of Particles with Excessive Uranium Dispersion Inside SiC

Procedure:	AGR-CHAR-DAM-28 Rev. 1
Operator:	John Hunn
Compact lot ID:	LEU01-49T-Z
Compact lot description:	Compacts of AGR-1 variant 3 coated particle composite LEU01-49T
Compact ID numbers:	22,57,74,51,53,71,15,40,48,11,31,35
DRF filename:	\\mc-agr\AGR\DefectiveIPyC\LEU01-49T-Z_DRF28R1.xls

Number of compacts from which particles were recovered:	12

Weight of sample of particles (g):	28.967
Number of particles in sample:	49516
Mean average weight/particle (g):	5.85E-04

Number of particles with excessive U dispersion:	0

Comments

Particles noted with <300 μm diameter kernel: 11/49516 (fraction of compact lot with this anomaly: ≤3.7E-4 at 95% confidence).
Particles noted with <20 μm thick SiC: 38/49516 (fraction of compact lot with this anomaly: ≤1.0E-3 at 95% confidence).
Other anomalies observed included highly aspherical kernel shapes, faceted particles, and defects related to goldspots (soot inclusions).

Operator

8-17-06

Date

For Information Only

The information in the remainder of this section is from additional characterization that was not required by the fuel product specification.

A. Images of AGR-1 variant 3 compact lot LEU01-49T-Z

The following images are of two compacts randomly selected from compact lot LEU01-49T-Z.

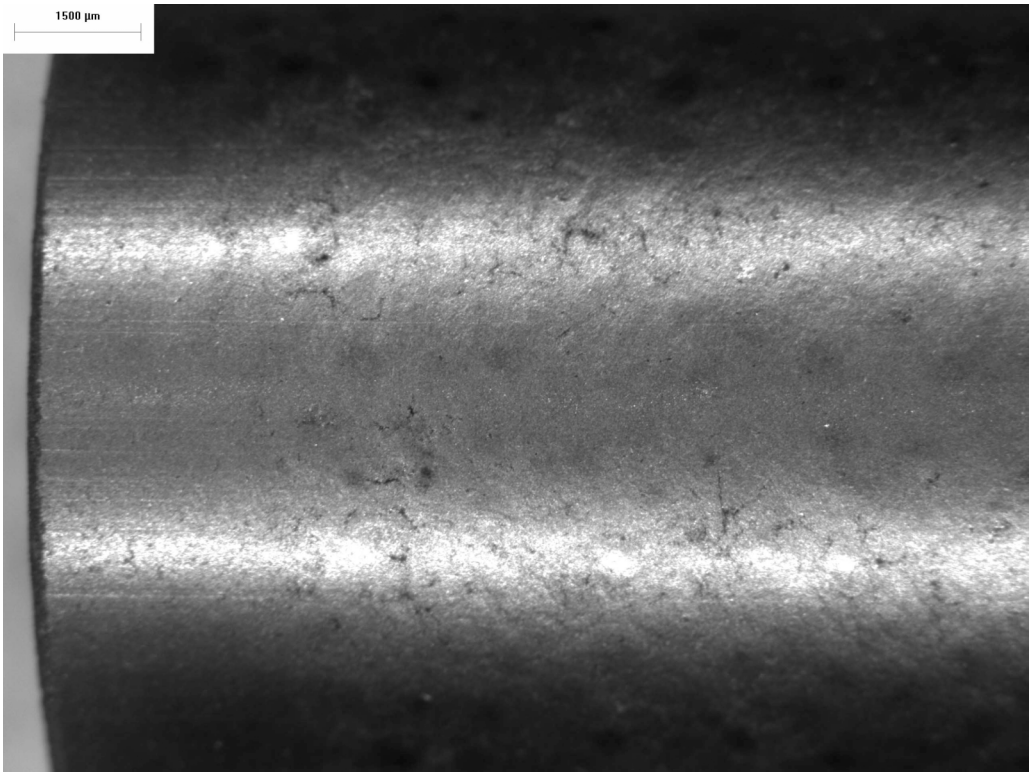


Figure A-1: Bottom of compact LEU01-49T-Z04 (28th compact fabricated).

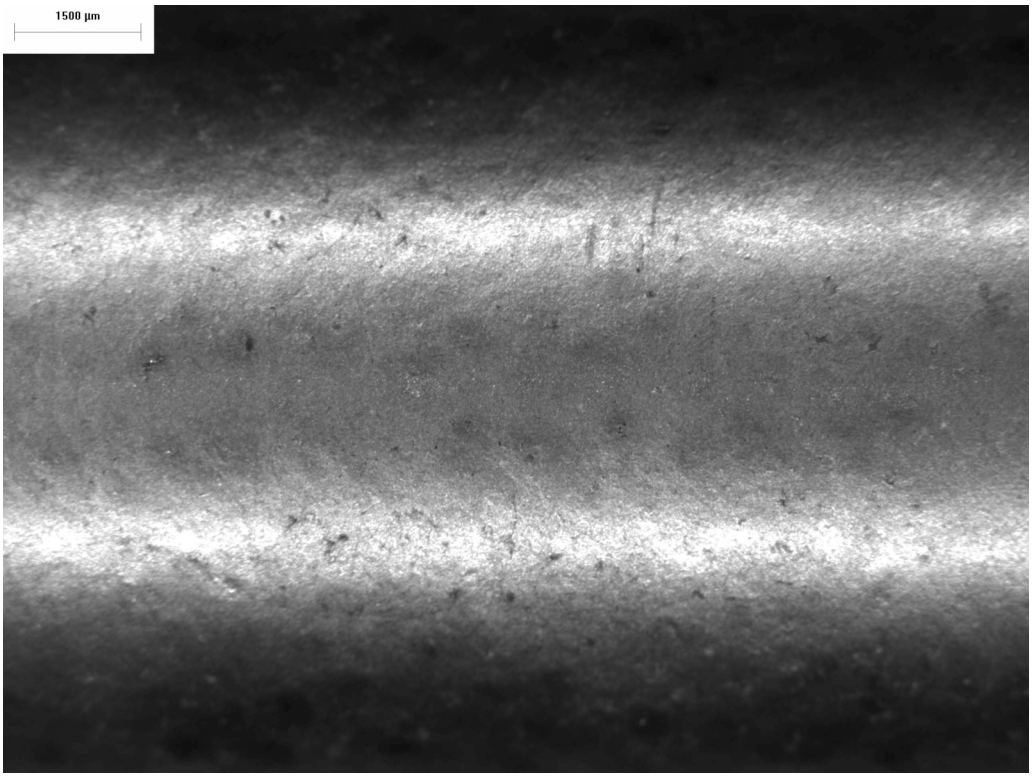


Figure A-2: Middle of compact LEU01-49T-Z04 (28th compact fabricated).

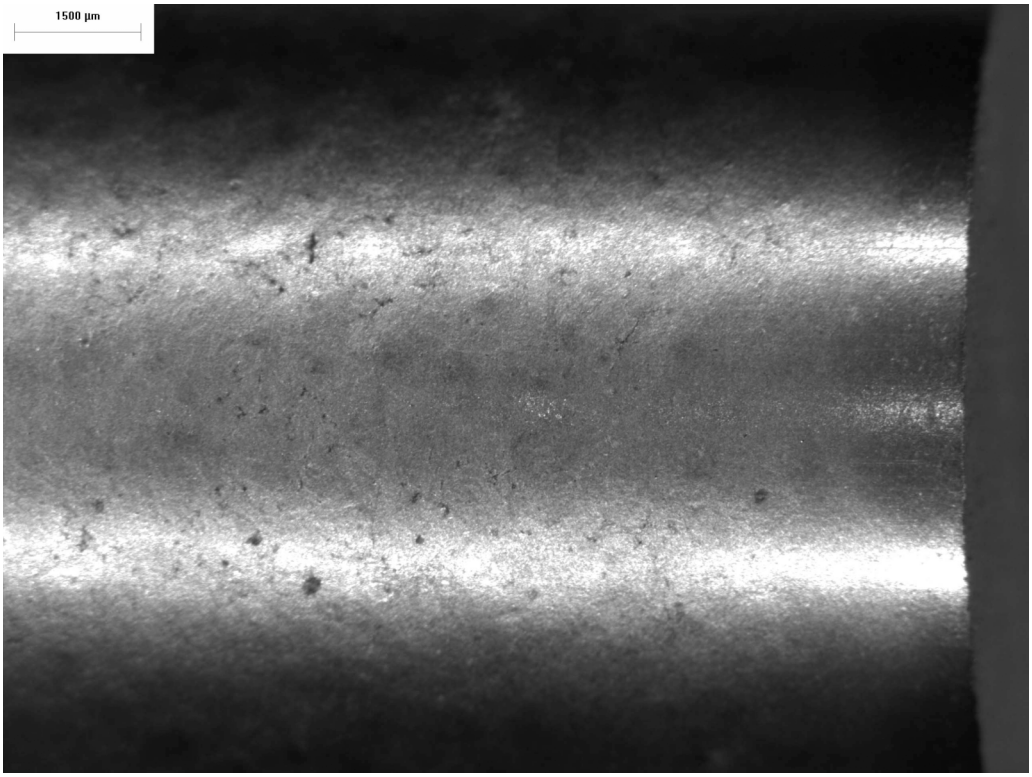


Figure A-3: Top of compact LEU01-49T-Z04 (28th compact fabricated).

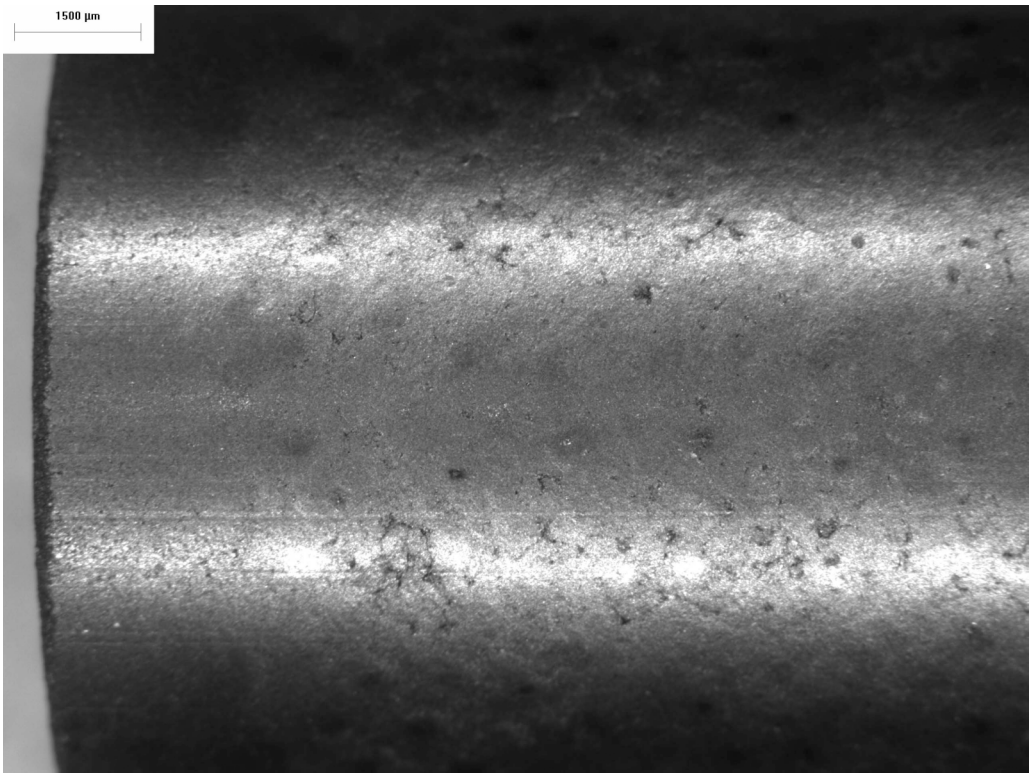


Figure A-4: Bottom of compact LEU01-49T-Z05 (11th compact fabricated).

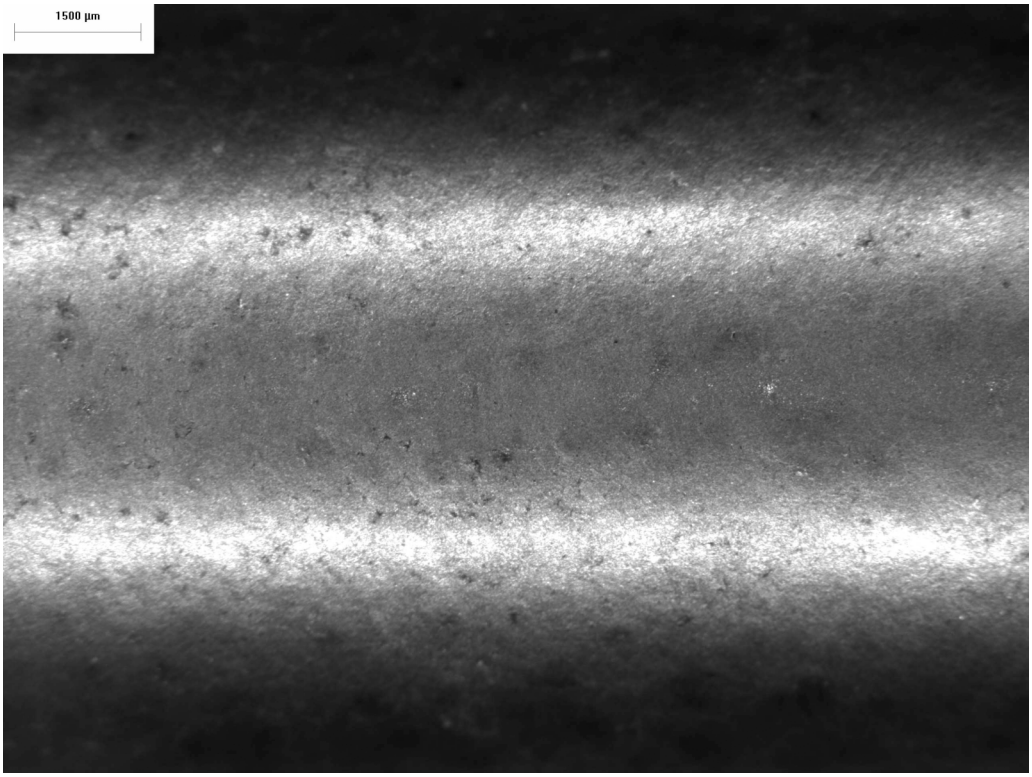


Figure A-5: Middle of compact LEU01-49T-Z05 (11th compact fabricated).

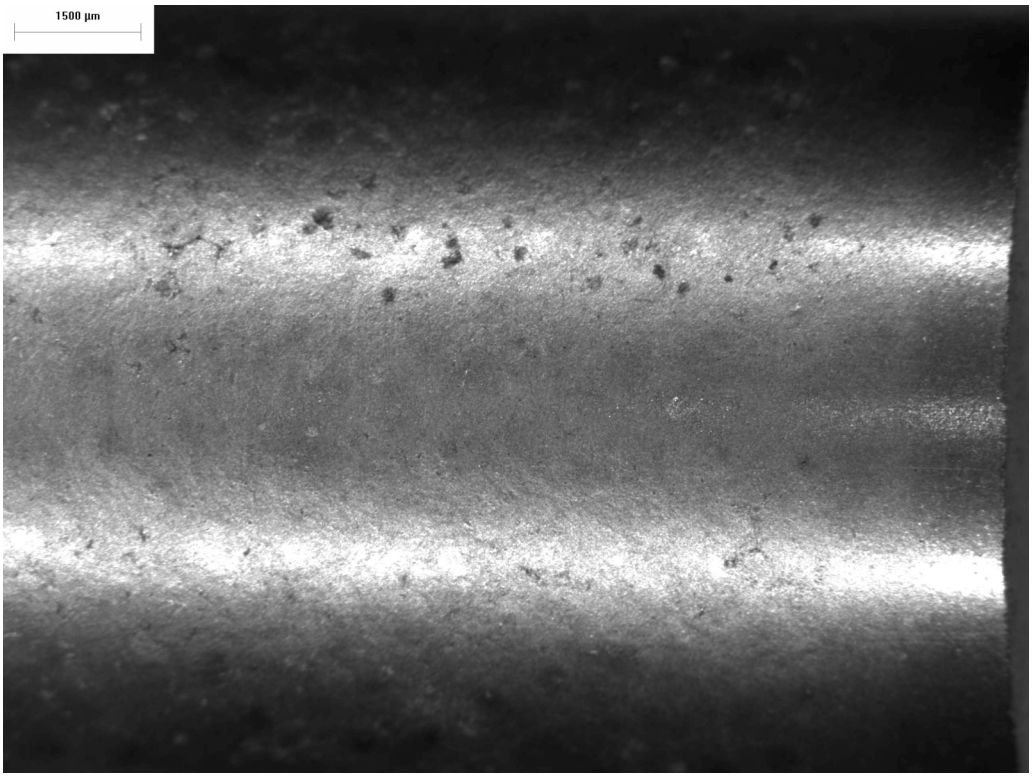


Figure A-6: Top of compact LEU01-49T-Z05 (11th compact fabricated).

B. Anisotropy of pyrocarbon layers after compacting

To examine the change in pyrocarbon anisotropy during compact fabrication, particles were recovered after deconsolidation of the particles from the compact for defective OPyC analysis. After compacting, the anisotropy of the pyrocarbon layers was observed to increase. This increase is thought to occur during the heat treatment of the compacts at 1800°C for 1 hour. The diattenuation of the IPyC increased from 0.0098±0.0007 to 0.0114±0.0009 (1.0293±0.0022 to 1.0341±0.0027 in terms of effective BAFo). The diattenuation of the OPyC increased from 0.0071±0.0008 to 0.0120±0.0007 (1.0214±0.0025 to 1.0360±0.0021 in terms of effective BAFo). The following two DRF's contain the data for these measurements.

Data Report Form DRF-18A: Measurement of Pyrocarbon Anisotropy using the 2-MGEM - IPyC

Procedure:	AGR-CHAR-DAM-18 Rev. 1
Operator:	G. E. Jellison
Mount ID:	M06072502L
Sample ID:	LEU01-49T-Z70
Sample Description:	Particles deconsolidated from AGR-1 variant 3 compact
Folder containing data:	\\mc-agr\AGR\2-MGEM\R06080301\

Particle #	Grid Position	Diattenuation			Equivalent BAFo		
		Average	St. Dev.	Ave. Error	Average	St. Dev.	Ave. Error
1	3,5	0.0118	0.0036	0.0012	1.0354	0.0108	0.0036
2	4,3	0.0114	0.0030	0.0012	1.0342	0.0090	0.0036
3	4,4	0.0112	0.0031	0.0010	1.0336	0.0093	0.0030
4	4,5	0.0115	0.0033	0.0010	1.0345	0.0099	0.0030
5	4,6	0.0109	0.0029	0.0010	1.0327	0.0087	0.0030
6	5,3	0.0106	0.0030	0.0012	1.0318	0.0090	0.0036
7	5,4	0.0118	0.0034	0.0012	1.0354	0.0102	0.0036
8	6,3	0.0135	0.0045	0.0013	1.0405	0.0135	0.0039
9	6,6	0.0104	0.0032	0.0014	1.0312	0.0096	0.0042
10	6,7	0.0107	0.0034	0.0015	1.0321	0.0102	0.0045
Average		0.0114	0.0033	0.0012	1.0341	0.0100	0.0036

Mean of average BAFo per particle:	1.0341
Standard deviation of average BAFo per particle:	0.0027

Comments

G. E. Jellison — Operator

8/3/06 — Date

Data Report Form DRF-18B: Measurement of Pyrocarbon Anisotropy using the 2-MGEM - OPyC

Procedure:	AGR-CHAR-DAM-18 Rev. 1
Operator:	G. E. Jellison
Mount ID:	M06072502L
Sample ID:	LEU01-49T-Z70
Sample Description:	Particles deconsolidated from AGR-1 variant 3 compact
Folder containing data:	\\mc-agr\AGR\2-MGEM\R06080301\

Particle #	Grid Position	Diattenuation			Equivalent BAFo		
		Average	St. Dev.	Ave. Error	Average	St. Dev.	Ave. Error
1	3,5	0.0121	0.0047	0.0013	1.0363	0.0141	0.0039
2	4,3	0.0110	0.0037	0.0013	1.0330	0.0111	0.0039
3	4,4	0.0127	0.0040	0.0011	1.0381	0.0120	0.0033
4	4,5	0.0117	0.0036	0.0011	1.0351	0.0108	0.0033
5	4,6	0.0126	0.0041	0.0011	1.0378	0.0123	0.0033
6	5,3	0.0114	0.0037	0.0013	1.0342	0.0111	0.0039
7	5,4	0.0133	0.0042	0.0012	1.0399	0.0126	0.0036
8	6,3	0.0116	0.0046	0.0014	1.0348	0.0138	0.0042
9	6,6	0.0115	0.0039	0.0016	1.0345	0.0117	0.0048
10	6,7	0.0121	0.0033	0.0016	1.0363	0.0099	0.0048
Average		0.0120	0.0040	0.0013	1.0360	0.0119	0.0039

Mean of average BAFo per particle:	1.0360
Standard deviation of average BAFo per particle:	0.0021

Comments

G. E. Jellison
Operator

8/3/06
Date