TP89 – SIRZ Decomposition Spectral Estimation

Isaac Seetho, Steve Azevedo, Jerel Smith, William D Brown, Harry E. Martz, Jr.
Lawrence Livermore National Laboratory
Livermore, CA 94551

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1. Experiment Lead: Isaac Seetho

Alternate: Jerel Smith

2. Objectives

The primary objective of this test plan is to provide X-ray CT measurements of known materials for the purposes of generating and testing MicroCT and EDS spectral estimates. These estimates are to be used in subsequent Ze/RhoE decomposition analyses of acquired data.

3. Summary of Approach

7 scan sets (100 kV 2 slit and 160 kV 2 slit) will be acquired on the HEAF MicroCT system, using known reference specimen materials in the upper slit. An additional 7 scan sets will be acquired on the Reveal CT80-DR. These scans will be used to refine a prior spectral estimate through comparison of experimentally measured transmission vs chord length and predicted transmission vs chord length. Revised spectra and prior spectra will subsequently be used to generate estimates of (ρ_e, Z_e) from acquired scans, which will be compared to ground truth. The expected result is that values obtained using the refined spectral estimate will adhere more closely to ground truth than stock spectral estimates (using default kV and filtration parameters).

4. Materials:

a) Calibration Reference Materials (see Table 1)
b) EDS Test Materials (see Table 2)

A total of 7 reference specimen materials will be scanned on the MicroCT system in each of two spectral configurations.

5. X-ray Systems:

a) MicroCT System
b) Reveal/Leidos CT80-DR

6. MicroCT Scans

Name	Reference	LEDP ID	Dia (mm)	Length (mm)
Specimen 1	Graphite	LR-GRA-02-02	50.8	25.4
Specimen 2	Teflon	LR-TEF-01-01	56	20
Specimen 3	Magnesium	LR-MAG-01-02	25.4	50.8
Specimen 4	Silicon[1]	LR-SIL-01-02	25.4	25.4
Specimen 5	Aluminum	LL-ALU-00-XX	25.4	50.8
Specimen 6	Delrin	LL-DEL-00-XX	50.8	20
Specimen 7	Water[2] (60 ml)	N/A	36.9/38.9	~55

[1] Operator will wear Nitrile Gloves while handling the Silicon sample

[1] Deionized Water, Fisher Scientific, Cat # 23-751-610, http://www.fishersci.com/ecomm/servlet/fsproductdetail?catalogId=29103&productId=11963016&langId=-1&storeId=10652&distype=2&isChemical=false&fromSearch=0

Table 1. *Materials to be used for data acquisition in MicroCT Set I.*

Scans taken on the HEAF MicroCT system will follow standard operating procedure, as outlined in [1]. If **acquired at a different site**, the following should be satisfied:

1. The spectral characterization scans should be taken over a 360 degree angular range, at half-degree increments.
2. Scanning should be done using that site's standard operating procedure and operating points at high and low spectrum, while satisfying condition (1).

7. HEAF CT80-DR Scans

Name	Reference	LEDP ID	Dia (mm)	Length (mm)
Specimen 1	Graphite	TA-GRA-00-D4	50.8	152.4
Specimen 2	Teflon	TA-TEF-00-D8	50.8	152.4
Specimen 3	Magnesium	TA-MAG-00-D4	50.8	152.4
Specimen 4	Silicon	TA-SIL-00-C4	50.8	152.4
Specimen 5	Aluminum	LL-ALU-00-XX	25.4	50.8
Specimen 6	Delrin	TA-DEL-00-C2	50.8	152.4
Specimen 7	Water	TA-H2O-00-C4	50.8	152.4

Table 2. *Materials to be used for data acquisition in EDS Set I.*

Scans taken on the HEAF Reveal CT80-DR system will follow standard operating procedure, as provided by Leidos/Reveal.

The spectral characterization scans should be taken with collection of raw data enabled, requiring data acquisition software version 5.5.0.40. Specimens for these scans shall be placed on a foam block and scanned 10x using bag bounce mode.

8. System Alignment

The MicroCT system must be aligned before any data acquisition. If the system is not aligned or there is reason to believe it may be out of alignment, the system will be aligned using the fine alignment SOP [2].

9. Data Transfer

The MicroCT data acquisition data will be placed on a server (e.g, the LEDP server at LLNL). The directory structure and naming convention will be:

W:\TP89_Decomposition_Spectral_Estimation\LLNL\None*MACHINE*\None*TYPE**DATE*_Wate*r_XX**ENERGY*

Where:

W:	Is the Windows® drive letter associated with the 'LEDP-Data\working' directory
MACHINE	Is the machine on which the associated data were acquired
TYPE	*Control* or *Test*. Defines either the 'controlled' scans using the MicroCT Test Bed Teflon reference or the test scans using the HEAF Teflon reference.
DATE	A 6-digit numeral in *yymmdd* format that gives the date on which x-ray CT scans began for a particular x-ray sample.
XX	Incrementing number that defines the order the data was taken. 1 through 6 for the 'controlled' data and 1 through 20 for the test data.
ENERGY	*100kV* or *160kV*. This is the corresponding energy for the data acquired. The 100kV data will be placed in the *100kV* folder and the 160kV data will be placed in the *160kV* folder.

10. Reconstruction and Data Analysis

Data acquired using the HEAF MicroCT system are to be reconstructed using LTT (most recent version), according to the standard LLNL HEAF MicroCT Reconstruction SOP [3]. Reconstructed images are to be analyzed following the LLNL HEAF MicroCT Data Analysis SOP [4].

11. References

1. I. Seetho, A. Dooraghi, K. Morales, *MicroCT: Acquisition of CT Imaging Data for Home Made Explosive Materials*, LEDP-MCT-SOP-003 Rev 1, LLNL-TR-713898, December 9, 2016.
2. C. Divin, *MicroCT: Fine Alignment Procedure*, LEDP-MCT-SOP-010, LLNL-TM-633212, April 5, 2013.
3. I. Seetho, K. Champley, K. Bond, *MicroCT: Reconstructing X-Ray Computerized Tomographic Images from Data Acquired on LLNL MicroCT Systems*, LEDP-MCT-SOP-004 Rev 1, LLNL-TR-713899, December 9, 2016.
4. I. Seetho, *MicroCT: Automated Analysis of CT Reconstructed Data of Home Made Explosive Materials Using the Matlab MicroCT Analysis GUI*, LEDP-MCT-SOP-007 Rev 1, LLNL-TR-XXXX, December 15, 2016.