ALLIANCE FOR ENERGY INNOVATION, LLC
MANAGING AND OPERATING CONTRACTOR FOR THE
NATIONAL LABORATORY OF THE ROCKIES

Microscopy (MICRO) Services Agreement

I. Parties to the MICRO Services Agreement.

The Alliance for Energy Innovation, LLC as Management and Operating (M&O) Contractor for the National Laboratory of the Rockies (Alliance/NLR), under U.S. Department of Energy contract No. DE-AC36-08GO28308, has been requested by the "Sponsor" named below to perform the Microscopy (MICRO) Services set forth in Section II, Scope of Services.

Sponsor		Contact name	
Address		Phone #	
		Fax #	
		Email	

Contractor	Alliance for Energy Innovation, LLC	Contact name	Katherine Jungjohann
Address	National Laboratory of the Rockies	Phone #	303-384-6598
	15013 Denver West Parkway	Fax #	
	Golden, CO 80401	Email	Katherine.Jungjohann@nlr.gov

II. Scope of MICRO Services.

Pursuant to this MICRO Services Agreement and subject to the attached terms and conditions, Alliance/NLR will assign a duly authorized employee to perform the following measurements:

(a) MICRO Test Services to be performed:

#	Service Description	Price	Total number of groups/ samples	Total Price
Sponsor will provide samples to Alliance/NLR in dimensions under 10 cm^3. At the conclusion of services, Alliance/NLR will provide a written report detailing the results, including any unusual results.				
1	**Laser Plasma Focused Ion Beam Cross-Sectional Imaging & Analysis** Base analysis: Alliance/NLR will use femtosecond laser milling within the vacuum column of a plasma focused ion beam-scanning electron microscope (PFIB-SEM) to reveal and polish a cross-section from the sample, up to several mm in dimensions. Alliance/NLR will then conduct basic SEM imaging of the cross-section and provide 10 images of sample morphology to the Sponsor. Advanced analysis add-on: Alliance/NLR will conduct high-magnification imaging (above 1kx), energy dispersive X-ray spectroscopy (EDS), electron backscatter diffraction (EBSD), air-free sample loading/unloading, data reconstruction for 3D analysis, and/or cryogenic conditions.	$2,169/sample base analysis $424/sample advanced analysis add-on $1,271/sample in cryogenic conditions	0 0 0	$0 $0 $0

2	**Laser Plasma Focused Ion Beam Chunk Lift-Out 3D Imaging & Analysis** Base analysis: Alliance/NLR will use a combination of femtosecond laser milling and plasma beam milling/polishing within the vacuum column of a plasma focused ion beam-scanning electron microscope (PFIB-SEM) to extract a chunk from a region of interest for 3D analysis, up to 500 µm in dimensions. Alliance/NLR will then conduct slice-and-view SEM imaging to provide the Sponsor with one 3D dataset of a chunk morphology. Advanced analysis add-on: Alliance/NLR will conduct high-magnification imaging (above 1 kx), energy dispersive X-ray spectroscopy (EDS), electron backscatter diffraction (EBSD), and/or air-free sample loading/unloading. Data processing add-on: Alliance/NLR will perform image segmentation and/or generate a 3D reconstruction from the dataset.	$3,874/sample base analysis $445/sample slice-and-view add-on $424/sample advanced analysis add-on $2,204/sample data processing add/on	0 0 0 0	$0 $0 $0 $0
3	**Laser Plasma Focused Ion Beam Buried Cross-Section Lift-Out for (Scanning) Transmission Electron Microscopy** Basic preparation: Alliance/NLR will use a combination of femtosecond laser milling and plasma beam milling/polishing within the vacuum column of a plasma focused ion beam-scanning electron microscope (PFIB-SEM) to extract a lift-out from a buried region (> 500 µm from the sample's surface) of interest. A standard lift-out will be 10-20 µm in height/width and <100 nm in thickness. Alliance/NLR will weld the lift-out onto a copper transmission electron microscopy (TEM) grid and provide the grid to the Sponsor. Advanced preparation add-on: Alliance/NLR will utilize air-free sample loading/unloading and/or cryogenic conditions during preparation of the lift-out.	$3,874/sample basic preparation $424/sample advanced preparation add-on $1,271/sample in cryogenic conditions	0 0 0	$0 $0 $0
4	**Argon Plasma Focused Ion Beam Lift-Out for (Scanning) Transmission Electron Microscopy** Basic preparation: Alliance/NLR will use argon plasma beam milling/polishing within the vacuum column of a plasma focused ion beam-scanning electron microscope (PFIB-SEM) to extract a lift-out from a region of interest in sample. Argon plasma is particularly useful for oxide materials. A standard lift-out will be 10-20 µm in height/width and <100 nm in thickness. Alliance/NLR will weld the lift-out onto a copper transmission electron microscopy (TEM) grid and provide the grid to the Sponsor. Advanced preparation add-on: Alliance/NLR will utilize air-free sample loading/unloading and/or cryogenic conditions during preparation of the lift-out.	$2,816/sample basic preparation $424/sample advanced preparation add-on $1,271/sample in cryogenic conditions	0 0 0	$0 $0 $0
5	**Oxygen Plasma Focused Ion Beam Lift-Out for (Scanning) Transmission Electron Microscopy** Basic preparation: Alliance/NLR will use oxygen plasma beam milling/polishing within the vacuum column of a plasma focused ion beam-scanning electron microscope (PFIB-SEM) to extract a lift-out from a region of interest in sample. Oxygen plasma is particularly useful for organic materials. A standard lift-out will be 10-20 µm in height/width and <100 nm in thickness. Alliance/NLR will weld the lift-out onto a copper transmission electron microscopy (TEM) grid and provide the grid to the Sponsor. Advanced preparation add-on: Alliance/NLR will utilize air-free sample loading/unloading and/or cryogenic conditions during preparation of the lift-out.	$3,239/sample basic preparation $424/sample advanced preparation add-on $1,271/sample in cryogenic conditions	0 0 0	$0 $0 $0

6	**Cryogenic Scanning Transmission Electron Microscopy Imaging & Analysis** Base analysis: Alliance/NLR will conduct cryogenic scanning transmission electron microscopy (cryo-STEM) imaging of a sample cooled by liquid nitrogen, leading to a sample temperature around -180 °C. The sample can either be pre-cooled (delivered to Alliance/NLR from the Sponsor in cryogenic storage) or cooled within the microscopy (delivered to Alliance/NLR at room temperature). Alliance/NLR will provide 10 images of sample at low magnification (<60 kx) to the Sponsor. Advanced analysis add-on: Alliance/NLR will conduct medium or high-magnification imaging (up to 500 kx), energy dispersive X-ray spectroscopy (EDS), electron energy loss spectroscopy (EELS), selected area electron diffraction (SAED), 4D-STEM, and/or cryo-removal of the sample (to return it to the Sponsor cold).	$2,937/sample base analysis $454/sample advanced analysis add-on $1,360/EELS or 4D-STEM add-on $5,508/sample strain or DPC data processing add-on	0 0 0 0	$0 $0 $0 $0
7	**4D-Scanning Transmission Electron Microscopy (4D-STEM) Analysis** Base analysis: Alliance/NLR will conduct four-dimensional scanning transmission electron microscopy (4D-STEM) analysis of a sample. Alliance/NLR will provide the Sponsor with 10 images of the sample at low magnification (<100 kx) and 3 4D-STEM maps at low- to medium-magnification (<500 kx). Advanced analysis add-on: Alliance/NLR will conduct high-magnification 4D-STEM mapping (>500 kx), energy dispersive X-ray spectroscopy (EDS), electron energy loss spectroscopy (EELS), and/or air-free sample loading/unloading. Data processing add-on: Alliance/NLR will process the 4D-STEM data to provide the Sponsor with phase/domain maps, strain maps, and/or virtual images including differential phase contrast images.	$2,937/sample base analysis $454/sample advanced analysis add-on $2,204/sample data processing add-on $5,508/sample strain or DPC data processing add-on	0 0 0 0	$0 $0 $0 $0
8	***Operando*-Freezing of Coin Cells for Cryogenic Electron Microscopy** Basic preparation: Alliance/NLR will conduct *operando*-freezing of a coin cell battery under applied current or bias (below 10 V and 0.1 A) at a point of interest within 30 min of the start of an electrochemical test. The Sponsor will provide Alliance/NLR with cold storage so the sample can be returned to the Sponsor cold, or the sample can be transferred for one of the cryogenic electron microscopy services described here. Extended test add-on: Alliance/NLR will conduct *operando*-freezing of a coin cell battery under applied current or bias at a point of interest within a longer electrochemical test.	$1,587/sample basic preparation $138/sample extended test add-on	0 0	$0 $0
9	**Semiconductor Cell and Module Electro-Optical Imaging** Base analysis: Alliance/NLR will conduct photoluminescence (PL) imaging, 10% I_{SC} electroluminescence (EL) imaging, I_{SC} EL imaging, and I_{SC} dark lock-in thermography (DLIT) on a cell (within a closed cabinet) or module (within a large dark curtained area). Image files are provided. Advanced analysis add-on: Alliance/NLR will conduct detailed zoom imaging for defect analysis and/or defect marking, cell conducting, and/or module coring to prepare a sample for transfer to microscopy analysis.	$1,442/cell base analysis $1,609/module base analysis $336/sample advanced analysis add-on	0 0 0	$0 $0 $0

10	**Semiconductor Excess Carrier Lifetime** Base analysis: Alliance/NLR will conduct transient photoconductive decay carrier lifetime measurements using an excitation wavelength from a tunable pulsed laser source with low- and high-injection levels relative to sample doping. Data and photoconductive decay plot results are provided. Advanced analysis add-on: Alliance/NLR will conduct variations in parameters such as spatial mapping and wavelength dependence.	$826/sample carrier lifetime base analysis $168/sample advanced analysis add-on	0 0	$0 $0
11	**Deep Level Transient Spectroscopy (DLTS)** Base analysis: Alliance/NLR will conduct DLTS measurements using electrical or optical carrier injection conditions over a cryostat temperature range that is typically 20 to 400 K. DLTS signal peak(s) plots and Arrhenius plots from defect signal fits that include defect energy level and concentration are provided. Advanced analysis add-on: Alliance/NLR will conduct variations in parameters such as for depth profiling and trap capture rates. Sample preparation, such as scribing or laser micromachining, may be needed for reducing sample area to a suitable capacitance value.	$1,274/sample base analysis $336/sample advanced analysis add-on $168/sample preparation	0 0 0	$0 $0 $0
	TOTAL			$0

(b) Estimated arrival date at Alliance/NLR **(c) IMPORTANT INFORMATION REGARDING SAMPLE CONDITION**

Estimated Pre-Paid delivery to Alliance/NLR: mm/dd/yy 15013 Denver West Pkwy Golden, CO 80401	The Sponsor is advised that all samples shipped to Alliance/NLR for MICRO Services must be non-hazardous and contained. It is the Sponsor's responsibility to package the samples sufficiently to prohibit damage. Alliance/NLR accepts no responsibility for damage incurred during shipment or any effect this may have on test results.

III. Acceptance and Certification.

Authorization of payment for the MICRO Services to be charged to the Credit Card provided on the website or by telephone, or payment received by Alliance/NLR for the MICRO Services via electronic funds transfer or check, constitutes Sponsor's acceptance of this MICRO Services Agreement and the terms and conditions of this MICRO Services Agreement. Sponsor agrees to pay the price of the MICRO Services in advance.

Sponsor is responsible for compliance with Export Control laws and regulations for all samples provided by the Sponsor to Alliance/NLR and all resultant measurement information provided by Alliance/NLR to the Sponsor.

CC: Contracting Officer, DOE Golden Field Office