UHV Manipulator With Cryostat and Five Degrees of Freedom

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REVISION HISTORY

Revision	*Date*	*Description*	*Author*
A	02-Apr-23	Original Draft	Ian Coulthard
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Table of Contents

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1.0 INTRODUCTION

1.1 PURPOSE

This document specifies the requirements for a UHV manipulator complete with 5 degrees of freedom and a liquid helium cryostat to be supplied and delivered to the CLS for use as part of a photoemission spectroscopy endstation.

1.2 SCOPE

The SGM spectroscopy beamline as specified by the user community requires high resolution and flux combined with a reasonably small beam size at the sample. This specification details the requirements for the fabrication, supply, testing, and delivery of a UHV manipulator complete with 5 degrees of freedom and a liquid helium cryostat. This specification includes but is not limited to:

- UHV manipulator
- Liquid helium cryostat
- Motorization
- Motor control
- Heating and temperature control
- Quality assurance
- Testing
- Delivery

1.3 BACKGROUND

The Canadian Light Source is a national facility under construction at the University of Saskatchewan campus in Saskatoon, Saskatchewan. This facility is a third generation synchrotron light source that will produce a high intensity source of infrared, visible, ultraviolet, and x-ray radiation. Based upon the needs of the Canadian synchrotron community, a soft x-ray spherical grating monochromator (SGM) spectroscopy beamline is being constructed with a goal of being ready for operation when the facility is declared operational in early 2004. One specific photoemission spectroscopy endstation being constructed for this beamline requires a UHV sample manipulator with five degrees of freedom with options for sample heating, cooling, and motorization.

2.0 GLOBAL REQUIREMENTS

2.1 The manipulator shall be capable of sustaining ultra-high vacuum (UHV) conditions. All factory vacuum test results for the manipulator shall be submitted to the CLS for approval prior to section shipment. These tests shall demonstrate a base pressure of better than $1 * 10^{-9}$ torr after bake out and shall include a residual gas analysis (RGA) spectrum. RGA tests should show that the sum of the partial pressures of gases having a mass >46 AMU does not exceed 10^{-11} torr in all chambers.

2.2 All flanges shall be of Conflat™ type.

2.3 The proponent shall determine the appropriate capacity of each stepper motor. Choice of motors and motor controllers shall conform to CLS stepper motor and stepper motor control policy [1] as much as possible. CLS shall either acquire the appropriate motors and deliver them for installation or shall authorize the proponent to acquire the motors themselves.

2.4 All sections of the manipulator shall be capable of sustaining at least 110 ^{o}C bake-out conditions.

3.0 MANIPULATOR REQUIREMENTS

3.1 The manipulator shall be mounted in a vertical orientation.

3.2 The five degrees of freedom of movement for samples mounted on the manipulator shall be lateral (Y), transverse (X), vertical (Z), polar rotation (Υ) and azimuthal rotation (Φ).

3.3 The vertical (Z) travel range shall be at least 300 mm.

3.4 XY travel shall be plus or minus 25 mm.

3.5 Polar rotation shall be at minimum plus or minus 180 degrees.

3.6 Azimuthal rotation shall be at minimum plus or minus 90 degrees.

3.7 The base flange shall have an outside diameter of 6 inches.

3.8 Azimuthal rotation adjustment shall be manually adjustable.

3.9 X,Y,Z, and polar rotation shall be motorized.

3.10 All motors shall operate in half-step mode.

3.11 Motor controllers at minimum shall allow for push button adjustment of the manipulator and preferably should allow for open and/or closed loop programmable control of the motors.

3.12 Sample heating should be accomplished through resistive heating up to at least 900 ^{o}C.

3.13 A temperature controller for the resistive heating is to be provided.

3.14 Sample temperature shall be monitored via thermocouple provided in the design and assembly of the manipulator.

3.15 The manipulator shall be equipped with a cryostat capable of use with both liquid nitrogen and helium.

3.16 The cryostat with the use of liquid nitrogen shall deliver approximately a sample temperature of 100 K or better.

3.17 The cryostat with the use of liquid helium and a sample thermal shield shall deliver approximately a sample temperature of 20 K or better.

3.18 The manipulator shall come equipped with a thermal sample shield ultra low temperature work. This shield shall be easily removable when it is not necessary.

3.19 The proponent shall provide the appropriate siphons for liquid nitrogen and liquid helium operations.

3.20 The manipulator shall be equipped with a differentially pumped rotary seal. This seal shall rotate the inner tube of the manipulator as opposed to rotating the entire manipulator.

3.21 A lead for measuring drain current from the sample shall be installed on the manipulator.

4.0 SAFETY, ENVIRONMENTAL, AND RELIABILITY

4.1 The manipulator shall be capable of operation in an ambient temperature range of 10 to 40 degrees C. The normal ambient temperature on the experimental floor is 21 degrees C. The expected temperature stability of the building will be 1 degree C during normal operation.

4.2 The manipulator shall be able to withstand a relative humidity range of 0% to 95%. The expected relative humidity limits under operation are from 25% during the winter months and a maximum of 50% during the summer months. The expected relative humidity range for components under storage will be the same as previously mentioned.

5.0 QUALITY ASSURANCE AND TESTING

5.1 The proponent shall maintain and apply a quality assurance program compliant with ISO-9001 for the manufacture, procurement, testing of the manipulator.

5.2 The manipulator shall be vacuum tested after arrival and installation at CLS for the purposes of remediation of vacuum leaks created during transport. This is in addition to vacuum factory testing done before shipment as stated earlier. Proponent shall verify out gassing and leak rate after installation.

6.0 APPLICABLE CODES, STANDARDS, AND PROCEDURES

This work shall meet the following standards. The issue of any standard shall be the issue in effect as of the date of request for tender. Any conflicts between this specification and the referenced documents shall be brought to the attention of the CLS in writing for resolution before any related action is to be taken by the proponent.

- American Welding Society (AWS)

- American Society for Testing and Material (ASTM)
- American Society of Mechanical Engineers, Boiler and Pressure Vessel Code
- (ASME-BPVC)
- American National Standards Institute (ANSI)
- International Standards Organization (ISO)
- Canadian Light Source Vacuum Component Cleaning Technical Procedure [2]
- Canadian Light Source Vacuum Component Leak Test Technical Procedure [3]
- Fasteners shall be American standard thread. Proponent may propose metric fasteners if spares are included.

7.0 OTHER REQUIREMENTS

7.1 The manipulator shall be delivered to the site designated by CLS by September 2002.

7.2 Packaging to be used during shipping of the manipulator shall ensure protection of the components from water, dust, oil, and vibration during shipping.

7.3 The manipulator shall be held securely in the shipping container to prevent chafing or scratching that could damage the component and / or generate contaminants.

7.4 Vacuum chambers should be shipped pressurized with dry nitrogen gas at a pressure slightly above the highest ambient atmospheric pressure.

7.5 The shipping containers shall be properly labeled in English to ensure proper care during shipment.

7.6 All documentation to the CLS shall be in English and conform to CLS document specification [4].

7.7 Documentation supplied to the CLS shall be provided in hard copy in triplicate plus one electronic copy if available. All drawings shall be supplied in AutoCAD format. All drawings and other documentation should also be appropriately labeled, numbered, and include a revision history.

8.0 REFERENCES

- E. Matias, “Control System Technical Specification”, 7.4.39.1 Rev. 2
- **Canadian Light Source Vacuum Component Cleaning Technical Procedure, 8.7.33.1, September 13, 2000.**
- **Canadian Light Source Vacuum Component Leak Test Technical Procedure, 8.7.33.2, September 13, 2000.**
- D.S. Lowe. “CLS Document Specification”, 0.4.1.1 Rev. 2 14 Dec 2000