Specifications

Project Title: Combined X-ray Excitation Source and Electron Energy Analyzer for Surface Analysis Using X-ray Photoelectron Spectroscopy (XPS)

Scope of Work:

The Naval Research Laboratory (Code 6876) wishes to purchase an x-ray source and electron energy analyzer to be used in constructing a system for the purpose of performing XPS on surfaces subjected to chemical processing. The two components (the source and the analyzer) are intended to work closely together as an integrated system.

I. X-ray source must meet the following specifications/requirements (QTY-1):

Anode Configuration: The source must contain two anodes and must allow the user to switch between the two without breaking vacuum or modifying the source configuration in any way.

Anode Materials: The anode materials must consist of an aluminum (Al) side and a zirconium (Zr) side. The source must be designed and constructed so as to allow the user to change this dual Al/Zr anode to any other combination of materials (such as dual Al/Mg) should future programmatic needs make this necessary. The anode substrate must be made of silver, rather than the standard copper, in order to avoid unwanted x-ray emission from the substrate.

Anode "Cross-Talk": The anode "cross-talk" must be less than 0.5%. This means that the intensity of the x-ray emission from the anode not being excited must be no more than 0.5% of that from the energized anode.

Anode Purity: The level of oxygen contamination in the anode materials must be sufficiently low that the O Kα emission intensity is no more than 3% of that of the metal-anode source emission line.

Window Materials: The source must include a thin metal foil window capable of transmitting at least 80% of the incident x-ray radiation at both the Al Kα emission line (with an energy of $h\nu$ = 1486 eV) and the Zr Mζ line (with an energy of $h\nu$ = 154 eV). The source must be designed and constructed so as to allow the user to replace the window or to change to a different window material as required. The vendor must be capable of supplying windows of any material consistent with the choice of dual-anode materials.

Linear Motion: The source must include a flexible bellows assembly allowing it to be translated in the axial direction over a distance of up to 100 mm without breaking vacuum.

External Pumping: The source must be designed and constructed so as to allow the addition of an external (appendage) vacuum pump in order to assist in the outgassing of the source. The metal foil window (cited above) must be designed and configured so as to allow differential pumping of the source by the external vacuum pump.

Water Cooling: The source must include all facilities (i.e., pump and control electronics) for water cooling. The cooling system must be designed and constructed

so that radiative heat from the source during operation does not cause the sample temperature to rise by more that 5 ºC.

Thermal Stability: The source must be bakeable to 250 ºC for compatibility with a typical ultra-high-vacuum chamber.

II. The electron energy analyzer must meet the following specifications/requirements (QTY-1):

Overall Design: The analyzer must be designed and configured as a 180º hemisphere complete with an electron lens so as to allow a well-defined angle between the x-ray beam and the photoelectron path. Variation of the entrance- and exit-slit widths must be achievable without breaking vacuum. The system must allow independent setting of entrance and exit slit widths and must allow energy scanning up to an electron kinetic energy of 3500 eV.

Construction: The analyzer must be constructed entirely of non-magnetic materials and must include a "mu-metal" shield for magnetic shielding.

Lens Design: The lens design must allow operation in different modes for high angular resolution or high spatial resolution, as required by the user. In angle-resolved mode, the acceptance angle must be continuously adjustable up to ±8°. In spatial-resolved mode, a lateral resolution as small as 120 microns is required. The lens operating characteristics must be capable of being controlled entirely by the software provided by the vendor.

Operating Distance: The analyzer must be designed and constructed so as to allow operation with a distance of up to 60 mm from the sample to the analyzer input. This is henceforth termed the "working distance".

Alignment: The analyzer must include an axial viewport affording a view of the sample through the electron lens so as to enhance the ease of sample alignment.

Computer Interface: The analyzer must be capable of interfacing with, and being fully controlled by, a standard PC running the 32-bit Windows XP operating system. The interfacing must not require any modification of either the PC or the analyzer control electronics.

Supporting Software: The analyzer must include all software needed for XPS data acquisition and analysis. The software must be compatible with a 32-bit Windows-XP computer. The software must also allow the analyzer to be used for Auger electron spectroscopy and must allow the user to vary the electron lens operating parameters so as to accommodate different working distances up to 60 mm. The software must allow for the application of a dispersion correction so as to optimize energy resolution and calibration. The data reduction and analysis software must include facilities for subtraction of backgrounds and satellites, smoothing, least-squares peak fitting, area integration and numerical differentiation.

Detector: The analyzer must be delivered with a 5-channel detector and must allow the addition of more channels, up to a maximum of 9, should future programmatic needs make this necessary. The analyzer must allow the addition of a spin-polarized detector (for magnetization studies), a CCD detec-

	tor (for imaging studies) or a delay-line detector (for time-resolved studies) should future programmatic needs make this necessary. The analyzer must be designed and constructed so as to allow the user to make these modifications "in the field", without the need for major disassembly or the return of the analyzer to the vendor.
Electronics:	The analyzer must be delivered with all the required control electronics. The electronics must be modular so as to allow replacement of components "in the field" as needed. A single set of control electronics must be capable of operating the analyzer in all modes for which it was designed. The power supply must operate without the need for voltage dividers.
Mounting:	The analyzer housing must include external "eye-bolts" or similar features to allowing the attachment of cables for the purpose of lifting with a crane. The analyzer must mount on the vacuum chamber *via* 6-inch Conflat (or, equivalently, a DN100CF) flange.
Thermal Stability:	The analyzer must be bakeable to 250 ºC for compatibility with a typical ultra-high-vacuum chamber.

Deliverable Schedule:

6 months after purchase.