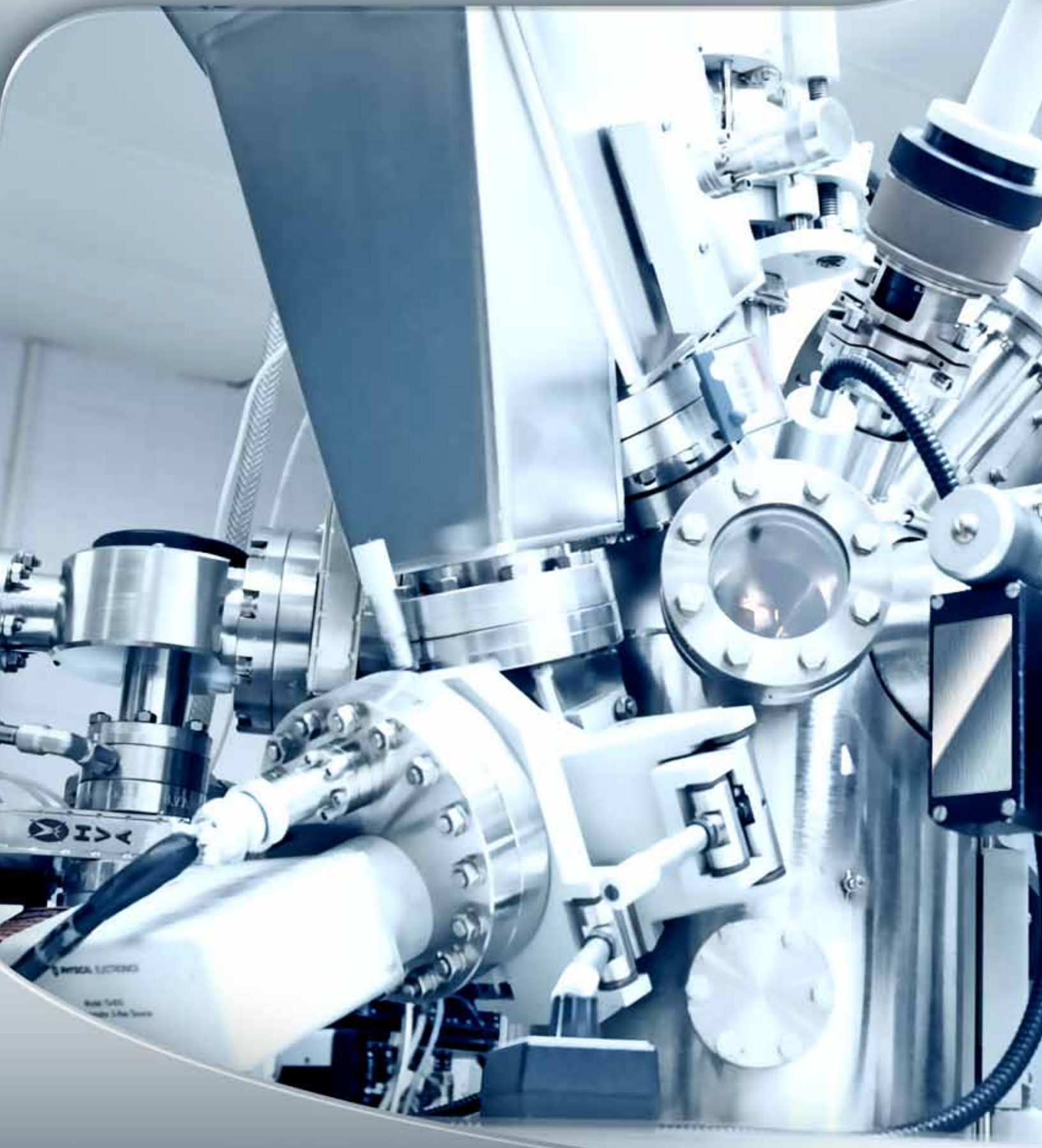
MATERIAL ANALYSIS LABORATORIES

Capabilities and Applications



CHEMICAL ANALYSIS

METHOD	INSTRUMENTS	APPLICATIONS
Atomic Absorption Spectroscopy	Two Perkin-Elmer AAnalyst 800 atomic absorp-tion spectrometers with WinLab32 AA software. Both the instruments offer automated atomizer exchange to switch from flame to graphite furnace mode and vice versa. The instruments are equipped with high performance burner systems for flame and a Transversely Heated Graphite Furnace (THGF) with long Zeeman-effect background corrector.	Quantitative elemental analysis of alloys, ores, WC, W, Mo, Co , cobalt hydroxide, metals, lumi-nescent chemicals, raw materials, gold plating so-lutions, ceramics, industrial wastes, different types of glass, R&D samples for different application, and environmental samples. Quantitative determi-nation of alkalis in a variety of materials.
Carrier Gas Fusion	LECO TC-436 oxygen/nitrogen, CS-600 carbon/ sulfur, and RC-412 multiphase carbon analyzers.	Residual oxygen/nitrogen determinations in metals, carbides, and alloys. Trace carbon/sulfur in metals, ceramics, and alloys. Free carbon in carbides.
Gas Chromatography	Agilent 3000 Micro GC. Agilent 6890/5973 GC-Mass Spectrometer, Agilent 3000A micro GC with FID/TCD.	Atmospheric gases and qualitative and quantitative analysis of organics.
Liquid Ion Chromatography	Dionex 2500/2100 Reagent Free IC and DX500 with auto-sampler.	Analysis of solutions for anions.
Classical Chemistry	Standard wet chemical and gravimetric laboratory equipment and supplies including balances and ovens, two Mettler automated titrators, pH meters, and ion analyzers. Auto digesting and distilling units. Automatic oil and grease analyzer.	Analysis of metal powders, chemicals, solid waste, and wastewater. Assays, drying losses, and loss on reduction. Refereeing instrumental analyses. Con-ductivity, pH, anion and ammonia determinations. Oil & grease measurements.
Thermal Analysis	Two Mettler Model SDTA851 Thermo Gravimetric Analyzers (TGA), Mettler moisture analysis balance, Netzsch STA 409C TGA and Netzsch DIL 402C Dilatometer.	Assays, drying losses, loss on reduction, loss on ignition, thermal shrinkage and expansion and dif-ferential thermal analysis up to 1500°C.
Fourier Transform Infrared Spectroscopy (FTIR) and Fourier Transform Raman Spectroscopy	Nicolet Magna 760 FT-Raman/IR spectrometer with Nic-Plan microscope, photo-acoustic, diffuse reflectance and ATR capabilities.	Quantitative and qualitative analysis of bulk and surface of organics and inorganics, including bonding and structural analysis. A spot as small as 10μ can be analyzed.
Mass Spectrometry	VG-9000 glow discharge mass spectrometer.	Survey analysis. Trace rare earth and W wire analysis. Quantitative elemental analysis of APT, W powder, and phosphors down to ppb.
DC-arc Optical Emission Spectroscopy	Teledyne Leeman Prodicy DC-Arc Spectometer. Thermo AtomComp 2000 High Resolution spectrometer with CID detector. Thermo AtomComp 2000 High Resolution Dual Slit spectrometer with CID detector.	Qualitative survey analysis of inorganics and metals. Quantitative multi-element trace analysis of luminescent chemicals, tungsten, molybdenum and cobalt.
UV-Visible Spectrophotometry	Hitachi U-2810 UV/Vis spectrophotometer.	A variety of single element determinations in low ranges; e.g., Fe, Ni, chloride, phosphate, nitrate.
X-ray Fluorescence Spectroscopy	Two PANalytical Axios wavelength-Dispersive spectrometers with full quantitative/qualitative software package including IQ+ for standardless applications. Sample preparation equipment includes two Phoenix VFD automated fusion machines for borate fusion. Claisse TheAnt automatic flux dispneser and three Mettler moisture analyzers	Major and minor components in refractory metals and phosphors. Bulk analysis of tungsten carbides. Trace analyses. Tungsten ore concentrate assays. Co and W scrap and sludge analyses. Qualitative survey analyses.
X-ray Diffraction	Rigaku D/Max automated system with two goniometers, sample changer, high temperature attachment, color graphics, and MDI Jade search/ match software.	Identification of unknown compounds. Quantitative analyses of mixtures. Study phase transitions at elevated temperatures. Lattice param-eter and crystallite size determinations.

ICP Spectrometer

X-ray Fluorescence Spectrometer

ICP Mass Spectrometer

CHEMICAL ANALYSIS

METHOD	INSTRUMENTS	APPLICATIONS
ICP Emission Spectroscopy	Both the Thermo Fisher Scientific iCAP 6500 ICP Spectrometer and IRIS ADVANTAGE ICP Emission Spectrometer are high resolution spectrometers with CID detection using TEVA™ software, capable of working in duo (axial and radial) mode. Pneumatic and ultrasonic nebulization techniques are available to use depending on sensitivity need and sample type.	Simultaneous multi-element quantitative determination of metals in wastewaters, leachates, process solutions, quartz sand and tubing, different types of glass, phosphors and raw materials. Multi-element semi-quantitative analysis of a variety of matrices. A range of quantitation level from trace to major is accomplished. Qualitative survey analysis.
ICP Mass Spectrometry	Perkin Elmer ELAN DRCII ICP-mass spectrometer equipped with DRC™ and Axial Field Technology uses a process called chemical resolution to eliminate plasma-based polyatomic interferences before they reach the quadrupole mass spectrometer with channeltron detector.	Simultaneous multi-element quantitative determination of metals at trace level. Qualitative survey analysis. Isotope information is available.
Microwave Sample Preparation	CEM Models MARS 5, 2100, and 2000 digestion systems.	Sample preparation for solution techniques.

INFORMATION MANAGEMENT

METHOD	INSTRUMENTS	APPLICATIONS
Laboratory Information Management System (LIMS)	Lab Vantage client/server LIMS with instrument connect architecture for interfacing major instruments.	Rapid acquisition, manipulation, distribution, and control of analytical results, quality assurance data, and management information.

SURFACE ANALYSIS / MICROSCOPY

METHOD	INSTRUMENTS	APPLICATIONS
Scanning Auger Microprobe (SAM); Electron Spectroscopy for Chemical Analysis (ESCA)	Physical Electronics Model 5702 SAM/ESCA equipped with a dual Al/Mg standard x-ray source and an Al monochromatic x-ray source plus ion gun for cleaning and depth profiling. Zalar rotation for uniform sputtering.	Qualitative and quantitative elemental analysis of top few atomic layers of metals, insulators, and semiconductors. Chemical states of elements. Depth profiling, elemental and chemical state mapping, point and line analysis, and secondary electron and backscattered imaging.
Sputtered Neutral Mass Spectrometry (SNMS); Secondary Ion Mass Spectrometry (SIMS)	SPECS Model INA3 SNMS/SIMS system (Leybold AG licensed); r.f. plasma or ion gun sputtering; quadrupole mass analyzer; high-frequency square wave (HFSW) voltage capability for insulator application.	High sensitivity qualitative and quantitative bulk or surface elemental analysis of conductors and insulators. Depth profiling with excellent resolution. Information about diffusion and interactions at interfaces. Detection and depth distribution information on additives, trace impurities, and ion-implanted species.
Scanning Electron Microscopy (SEM)	Hitachi S-3000N SEM with large stage, full automation, low voltage, variable pressure, and Quartz PCI System for web-based collaboration.	Secondary electron and backscattered electron imaging. Study particle morphology, coatings, defects.
Energy Dispersive X-ray Spectroscopy	Integrated Oxford INCA 400 EDS system.	Identification of elements (Z>4) including quantitative and semi quantitative analysis of inclusions, particles, and surface contaminants. X-ray mapping. Image analysis, including acquisition, processing, and storage.


Scanning Electron Microscope


Scanning Auger Microscope (SAM) and X-ray Photoelectron Spectrometer (XPS, ESCA)


XR F Sample Preparation Area

PHYSICAL TESTING

METHOD	INSTRUMENTS	APPLICATIONS
Chemisorption	Micromeritics ASAP 2010 Chemi System	Catalyst activity: number of active sites, active area, metal dispersion, heat of adsorption, via chemical adsorption of active gases.
Density, Apparent	Scott Volumeter; Hall Flow Cup	Apparent (bulk) density of powders.
Density, Absolute (Skeletal)	Micromeritics AccuPyc 1330 Helium Pycnometer	Absolute (near-theoretical) density of non-porous solids; % closed porosity of porous solids. Powders and small solid pieces.
Density, Envelope	Micromeritics GeoPyc 1360	Envelope density of small, solid pieces (e.g., green powder compacts) by measurement of outer, enclosed volume.
Density, Immersion	Mettler XS204 Analytical Balance	Water immersion density of small, solid pieces with no open porosity.
Fisher Number	Fisher Sub-Sieve Sizer	Average particle size estimate based on air permeability of packed powders.
Flowability	Hall and Carney Flowmeters; Hanson Flodex Powder Flowability Test Apparatus	Flow rate of powders; flowability index over an arbitrary scale of 4-40.
Fracture Toughness (Indentation)	Wilson Tukon Series 200 Microindentation hardness tester; Nikon Epiphot 200 Microscope	Fracture toughness (KIC) via measurement of hardness indentations and cracks emanating there from.
Hardness	Instron/ Wilson Rockwell Series 2000 hardness tester; Wilson Tukon 200 microindentation hardness tester	All Rockwell scales, Knoop, DPH (diamond pyramid hardness), Vickers for ceramics, metals (rod, sheet, plate, wire), and cemented carbides.
Instrumented Impact (Charpy)	Tinius Olsen Model 74 with Dynatup instrumentation	Absorbed impact energy and dynamic fracture data for metals and ceramics.
Metallography	Nikon Epiphot 200 Microscope with Clemex digital camera; Olympus SZX16 Stereomicroscope with DP70 digital camera; Standard equipment for metallographic specimen preparation, including automated polishing.	Metallographic analysis (grain size, % re-crystallization, phase analysis, etc.) of powder, ingots, rod, wire, fabricated metal parts. Observation and photomicrographs of metals, ceramics, and cemented carbides. Electronic image storage and transmission.
Particle Size Distribution	Microtrac S3500 and UPA 150; Alpine Air-Jet Sieve; Tyler Portable Sieve Shaker	All powders, particle size range covers from 0.003 to 1408 micrometers.
Surface Area, Porosimetry	Beta Scientific Model 4203 Surface Area Analyzer; Micromeritics ASAP 2010 Accelerated Surface Area and Porosimetry System	Single point estimation and full-isotherm surface area of powders (BET, Langmuir theories). Pore size distribution analysis, including microporosity, via gas adsorption techniques.
Room and High Temperature Tension /Compression/ Compressibility	Tinius Olsen H50KS (11,000 lb.); Tinius Olsen Model 60 Super "L" (60,000 lb.) 1706 GS H2FL CM Furnace (up to 1700°C)	Ambient and high temperature mechanical properties: compressive strength, compressibility, transverse rupture strength, and green strength of powders, compacts, ceramics, and metals; tensile strength, yield strength, elongation, elastic modulus, on wire, rod, sheet (foil), and machined tensile specimens.
Wear Rate/Coefficient of Friction	Falex Multi-Specimen Test Machine	Determination of wear rate and coefficient of friction of materials in rubbing contact.
Zeta Potential/ Isoelectric Point (IEP)	Colloidal Dynamics ZetaProbe	Surface charge characteristics of particle-liquid systems. Determination of point of zero charge (IEP) via pH titration.

LABORATORY INFORMATION

GTP's Materials Analysis Laboratories at Towanda are accredited for chemical and mechanical testing by the American Association for Laboratory Accreditation. This accreditation recognizes that the laboratories, within the scope of their accreditation, meet the requirements of ISO/IEC 17025, "General Requirements for the competence of Testing and Calibration Laboratories." Testing laboratories that comply with this International Standard also operate in accordance with ISO9001-2000. Additional information on this accreditation, including the scope, is available upon request. Analytical services are available to other groups in the corporation and to outside customers. Price schedules are available on request. For further information, write or call the Materials Analysis Laboratory Manager at Global Tungsten & Powders Corp., 570-268-5341.