Metallurgical Experimental Center of USTB Equipment Instruction

The Metallurgical Experimental Center, attached to School of Metallurgical and Ecological Engineering of University of Science and Technology Beijing (USTB) and Capital Experimental Condition Platform, is a research institution of metallurgical science and technology. With advanced apparatus and abundant approaches, The Experimental center undertook experimental projects from various units inside and outside university. It currently possesses instruments and apparatus of totally worth of RMB 20 million, including 7 equipments costing more than RMB 1 million each and 30 larger-scale other equipments, all of which work at concert pitch. As a vehicular for researching, the experimental center will offer great services for the research of school, university and society.

More information can be seen in the subsequent table.

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<td>62333797</td>
<td>Room109, Metallurgical Building</td>
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<td>JSM-6701F Field emission scanning electron microscope (FESEM) Thermo NS7 Energy Dispersive spectrometer (EDS)</td>
<td>FE-SEM &amp; EDS</td>
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<td>SEM &amp; EDS</td>
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<td>AA-6800 Atomic absorption spectrophotometer</td>
<td>Element analysis (Containing graphitic crucible)</td>
<td>82375799</td>
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<td>AA-6300 Atomic absorption spectrophotometer</td>
<td>Element analysis</td>
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<td>OPTIMA 7000DV</td>
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<td>TCH600 O, N &amp; H analyzer</td>
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<td>GCMS_QP2010 Gas chromatography-molecular mass spectrometry detector</td>
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<td>Electroslag furnace</td>
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<td>Vacuum carbon tube furnace</td>
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<td>Iron ore powder sintering and pelletizing machine</td>
<td>Iron ore powder sintering and pelletizing</td>
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</table>

**5. Instrumental Analysis Lab**

**Room 107, Metallurgical Building**

**Room 803, Metallurgical Building**

**6. Workshop**

**Workshop, Metallurgical Building**
**Apparatus:**
X-ray photoelectron spectroscopy (XPS) AXIS Ultra DLD

**Function:**
X-ray photoelectron spectroscopy (XPS) - AXIS Ultra DLD, made by Kratos company Japan, is mainly used for surfacial composition analysis of solid sample; chemical element images; valence band structure; crystal structure analysis and depth profiling. It can be used for inclusion component analysis of metal and alloy; elements depth analysis in slag, mineral phase and materials, etc. It can give specific massage of element changing of every layer (including valence state, content, distribution and element images); applying to non radioactive and non volatile metals, alloy semi-conductor, semi-conductor, isolater, powder and sin-film, etc.

**Performance index:**
- **X-ray radial sauce:** energy: 1-15KV; target (anode): double anode (standard); material of target: Mg/Al; maximum power: 0.45kw
- **Electron energy analyzer:** Type: 180° semi-spherical mirror plus spherical mirror; average radius: 165mm
- **Analyzer electronics:** Fixed analyzer transmission - FAT scanning, fixed retardant rate - FRR (choosable); Energy range: 0-3200ev, 0-1500ev (high resolution); Flux energy: programmable, 5-320ev
- **Analysis room:** 15 directing analysis point, 267mm diameter; magnetic shielding: bilayer μ metal; vacuum degree: 7×10-8Pa, 2×10-8Pa
- **Sample control:** sample stage: XYZ θ (auto/manual); sample number: 1/10/changable
- **Electron sauce (eligible):** energy: 10kev; Working Distance: 26mm; magnification: ×25-150000
- **Monochromator:** 500mm Rowland circle; crystal: quartz; maximum power: 0.450kw
- **Sensitivity:** Nonmonochromatic Mg Ka 450W; FWHM=0.8eV Big beam spot: 1100000; 110μm: 200000; 55μm: 12000; 27μm: 3000; 15μm: 500

**Location:** Room 109, Metallurgical Building

**Operator:** Feng Ting

**Tel:** +86-010-6233797, +86-010-62332525
**Apparatus:**
Field emission scanning electron microscope JSM-6701F & Energy Disperse Spectroscopy (EDS) NS7

**Function:**
Compared to SEM, it has higher spatial resolution and stability. It has high secondary electron image resolution ratio, continuous adjustable amplification factor, big depth of focus, combined topography observation and composition analysis, and simple sample making. The accessory X-ray EDS can do micro distinct analysis, with highly sensitive detector, high flux full digital pulse processor, digital image and powerful software function as well.

Mainly used for nonmagnetic substance.

**Performance index:**

1. **FE SEM:**
   - Distinguishability: 1.0nm (accelerating voltage: 15kV);
     2.2nm (accelerating voltage: 1kV)
   - Accelerating voltage: 0.5kV ~ 30kV
   - Amplification factor: ×25 ~ ×650,000;
     ×100 ~ ×650,000(SEM mode), ×25 ~ ×19,000(LM mode)
   - Beam current range: 10-13 ~ 2×10^-9A
   - Two stage condenser
   - Sample chamber: the maximum loading diameter is 150mm.
   - Electron gun: full-automatic taper field emission gun

2. **EDS:**
   - Elementary analysis range: Be (4) ~ U (92)
   - Detector crystal area: ≥10mm²
   - Distinguishability: > 132 eV, Mn Ka line >5000cps
   - Maximum distinguishability of image taken and display is 4096×4096×16bit

**Location:** Room 109, Metallurgical Building

**Operator:** Cheng Jin

**Tel:** +86-010-62333014, +86-010-62333797, +86-010-62332515
**Apparatus:** Scanning electron microscope (SEM) JSM-6480LV & Energy Disperse Spectroscopy (EDS)

**Function:**
Scanning electron microscope (SEM) and Energy Disperse Spectroscopy (EDX) is a high-end analyzer used for composition and phase analysis, which is a very important tool and widely used in material and metallurgical research. It can be used for material surface analyzing, images, secondary electron images and reflected images under high-low voltage, and coarse vacuum as well.

**Performance index of SEM:**
- Distinguishability of Second electron image: 3.0nm (30kV); 4.0nm (LV)
- Amplification factor: ×5 ~ ×300000
- Accelerating voltage: 0.5kV ~ 30kV
- Beam current: 1pA ~ 1μA
- Low vacuum degree: 1 ~ 270Pa
- Image mode: secondary electron image, backscattered electron image.
- Sample size: diameter ≤ 200mm; height ≤ 80mm

**Performance index of EDS**
- Distinguishability: 133ev, (Mn Kα, 1000 ~ 3000cps)
- Elementary analysis: B(5) ~ U(92)

**Location:** Room 105-2, Metallurgical Building

**Operator:** Wang Lianwei

**Tel:** +86-010-62332337, +86-010-62332515
Apparatus:
Polarization microscope image analyzer DMRX

Function:
Polarization microscope image analyzer DMRX, made by Laitz, Germany, is provided with infinity optical system. Its objective lens is unstressed and unaberrational, and has wide field of vision, high sharpness and advanced lighting system, which ensure the image contrast and light uniformity. The equipment is also equipped with large size stable vortical objective table.

Image analyzer Q500, offered by LEICADC100IW, Cambridge of England, is provided with digital camera lens DC100. It is a true colour camera, with RGB mode and colour depth 24BIT, is able to separate 16.7 million colours. Thus it is appropriate for image manipulation. It can do real-time image taking, 24 pictures per second; and has image analysis software, including interactive testing and automatic testing, which is suitable to test the gray level, size, acreage, perimeter, acreage percentage and grain quantity. The software package contains QUIPS macro software language and is able to record the image manipulation and operational program. Software programs can be edited as needed to improve quantitative measurement rate.

Large-scale polarization microscope DMRX plus image analyzer Q500 can do qualitative and quantitative photographing and micro observation analysis to the materials such as: ferrous materials, fireproofing, coke, coal, etc.

Large-scale polarization microscope DMRX plus hot stage can warm and cool materials such as: ferrous materials, fireproofing, coke, coal, etc; and qualitative and quantitative photographing and micro observation analysis to the phase transformation and crystal transfer at different temperatures. The maximum temperature is 1750°C.

Location: Room 105-1, Metallurgical Building
Operator: Liang Delan
Tel: +86-010-62332138, +86-010-62332515
| **Apparatus:** | Steel phase analysis system  
Including: 1) Leica metallurgical macroscope DM6000M  
2) Inclusion component calculating software  
Thermo-Calc  
**Function:**  
DM6000M, made in 2004 by Leica, German, is a full-automatic intelligent material microscope. The intensity of light source, aperture diaphragm and relative parameters can be adjusted to ideal condition as objective lens and observation method change, thereby clarify the images. Its function contains: light and dark field, polarized light, transmission (Biological samples) and automatic differentiation interferenc…etc. It can also mark the sample as needed. The distinguishability of camera is 3,000,000 pixel and amplification factor is 50-1000. It is mainly used in the observation and image analysis of inclusions and structure of metallographical sample. Software SISC IAS8 can collect real-time images clearly, and make various quantitative analysis for them, such as quantity statistics of metallurgical phases, automatic statistics and evaluation of inclusion, grain fineness number analysis, macrohardness measurement and multi-phase area percentage analysis…etc.  
Thermodynamics calculating sofetware is TCCR, the classic version of Thermal-Calc. Developed by The Royal Institute of Technology (KTH), it can calculate the equilibrium of complex Heterogeneous phase, multicomponent phase diagram, and Thermodynamics factor…etc.  
**Location:** Room 1101, Metallurgical building  
**Operator:** Wang Wanjun  
**Tel:** +86-010-62332522/62332515 |
| **Apparatus:** | Leica metallurgical macroscope DM4000M  
**Function:**  
DM4000M, made in 2004 by Leica, German, is a full-automatic intelligent material microscope. The intensity of light source, aperture diaphragm and relative parameters can be adjusted to ideal condition as objective lens and observation method change, thereby clarify the images. Its function contains: light and dark field, polarized light, transmission (Biological samples) and automatic differentiation interferenc…etc. It can also mark the sample as needed. The distinguishability of camera is 3,000,000 pixel and amplification factor is 50-1000. It is mainly used in the observation and image analysis of inclusions and structure of metallographical sample. Software SISC IAS8 can collect real-time images clearly, and make various quantitative analysis for them, such as quantity statistics of metallurgical phases, automatic statistics and evaluation of inclusion, grain fineness number analysis, macrohardness measurement and multi-phase area percentage analysis…etc.  
**Location:** Room 906, Metallurgical building  
**Operator:** Cheng Yu  
**Tel:** +86-010-62332534 |
### Apparatus: X-ray fluorescence spectroscope XRF-1800

**Function:**
This equipment is mainly used in the research areas of electric, magnetic materials, chemical industry, petroleum, coal, ceramics, cement, steel-making, non-ferrous metal, geology and mineral products.
Analysis range of elements: F(9) - U(92)

**Performance index:**
- X-ray tube: 4Kw thin window Rh target window type.
- Maximum power: 60KV 140mA
- Output stability: ±0.005% output voltage fluctuation +15%--10%
- Sample room: 8 sample turn table, Sample rotating: 60rpm X-ray irradiating
- Scanning speed: superspeed scanning:300° /min quantitative and qualitative analysis; 250um micro distribution analysis

**Location:** Room 104, Metallurgical building
**Operator:** Zhang Ying
**Tel:** +86-010-62333597, +86-010-62332515

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### Apparatus: X-Ray Diffractomer (XRD)

**Function:**
Super power X-Ray Diffractomer M21X, made by MAC Science Co.Ltd Japan, is mainly used in phase identification; matter structure; hot metal; refractory matter property testing and metallurgical process mechanism testing. The working atmosphere is air or argon gas. It appoint with computer control system, data acquisition and analysis software and data base PDF2, etc.

**Performance index:**
- The maximum power of X-ray diffraction radio-frequency generator is 21kw, rated tube voltage is 20—60kv; maximum rated current is 500mA;
- Two Vertical wide angle goniometers, radius of angle goniometers is 185 mm, 2θ angle measurement range is 0o~120o, right side is used for room temperature sample, left side is used for high temperature accessory;
- Automatic rotating anode (SRA), oscillation is less than 0.2μm, automatic adjustable aperture unit, stability is less than 0.005%;
- High temperature accessory (The maximum temperature is 1200°C), working in air/argon atmosphere, vadose water cooling system

**Location:** Room 104, Metallurgical Building
**Operator:** Zhang Ying
**Apparatus:**
Multiple thermoanalyzer STA409

**Function:**
Multiple thermoanalyzer STA409, made by NETZSCH, Germany, is composed of the mgavimetric analyzer, differential thermal analyzer, calorimetric analyzer and mass spectrum analyzer. With ultra-temperature measurement and middle-to-high temperature thermal analysis mass spectrometer, on-line off-gas can be analysed, which is at the advanced level of the world. And accessory equipments like differential scanning adiabatic calorimeter DSC204 and thermal dilatometer DIL402 work as auxiliary

**Research area.**
Research field: thermal stability; component analysis; melting point testing; decomposition temperature; reduction temperature; decomposition dynamics; material inoxidizability; material synthetic technology.

Used with QMS at 1400°C can analyse resolved Cemergent gas.

**Performance index:**
- Temp range: 25°C~1400°C, 25°C~2000°C
- Sample weight: 0~20 g
- Weighting scope 0~50 g
- Heating rate 0.1~50K/min

Environmental atmosphere of the sample can be chosen 25°C~1400°C in the air, or 25°C~2000°C in Argon gas.
**Location:** Room 103, Metallurgical building  
**Operator:** Zhang Mei  
**Tel:** +86-010-62333474, +86-010-62333014, +86-010-62332515

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**Apparatus:**  
Thermal expansion analyzer DIL402

**Research field:**  
Coefficient of thermal expansion; phase transformation; Glass Transition Temperature; sintering rate control; Influence of annexing agent; dynamics research of sintering.

**Performance index:**  
- Temperature range: 25 °C~1500°C  
- Heating rate: 0.1~10K/min  
- Sample size: Φ12 ㎜(max) × 25 ㎜(max)  
- Working atmosphere: inert/oxidation/reducing atmosphere

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**Apparatus:**  
Differential scanning adiabatic calorimeter DSC204

**Function:**  
Melting point; glass transition temperature; phase transformation temperature; melting heat; heat of crystallization; purity; specific heat; oxidation induction period; crystallinity.

**Performance index:**
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<th><strong>Temperature range:</strong></th>
<th>-170~700°C</th>
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<tr>
<td><strong>Heating rate:</strong></td>
<td>0.1~50K/min</td>
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**Location:** Room 103, Metallurgical building  
**Operator:** Zhang Mei  
**Tel:** +86-010-62333474, +86-010-62332515

**Apparatus:** Laser Particle Sizer LMS-30

**Function:**
Laser Particle Sizer LMS-30, made by Japan fresh Co., LTD, is mainly used for performance measurement of powder with size of 0.1—1000μm (metal powder, nonmetal mining powder, coal powder…etc), for the grain size, size distribution, specific surface area and processing disperse. The testing costs little time and the result is calculated by computer, obtaining the data steadily and accurately. It can be used in many field such as the injection powder of furnace, sinter pellet powder, environmental protection, powder metallurgy, food making, medicine making and chemical industry…etc.

**Performance index:**
Principle: Laser diffracting, scattering.  
Measure scale: 0.1~1000 μm  
Optical source: Semi-conductor (Wavelength 670nm)  
Size: Noumenon: 650 (W) × 315 (D) × 400 (H) mm  
Loop body: 200 (W) × 450 (D) × 400 (H) mm  
Weight: Noumenon :40kg; loop body :20kg  
Power source: AC100V  5A  

**Location:** Room 102, metallurgical building  
**Operator:** Song Zhongping
**Apparatus:** Powder property multifunction MT-1000

**Function:**
Powder property multifunction MT-1000, made by Japan Fresh Co., LTD, is mainly used for property analysis of powder evaluation, grain design, breaking system and powder transmission system. The resolution and characteristic of measured value took use of Chili Sauce index and Carr index, in cornside with the JIS testing method of apparent density, can be used widely.

**Performance index:**
1. 13 kinds of property of powder can be analyzed as follows:
   1) Apparent density 2) Tap densit y(Centain volume method) 3) Tap density y(Centain weight method) 4) Depositional gradient angle 5) Board spoon angle 6) Collapse angle 7) Dispersion degree 8) Agglutination degree 9) — 13) 5 Kinds of tap denstiy (JIS method)
2. Flowability and adhesive force can be calculated;
3. Tap density, measured by Centain volume method in powder industry can be resolved by Chili Sauce vibrate-condense formula and obtain final tap density, flowability, adhesive force, primary and final voidage. Container of 50cc, 25cc and 20cc size can be chosen, and the containers for a small amount of specime as well.
4. Can calculate Carr flowability index and floodability index, which are property indexes of powder materials. Carr index can be calculated by 7 measured values and 3 affiliated values, which can be obtained by the equipment.
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<th><strong>Location:</strong></th>
<th>Room 102, Metallurgical building</th>
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<tr>
<td><strong>Operator:</strong></td>
<td>Song Zhongping</td>
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<tr>
<td><strong>Tel:</strong></td>
<td>+86-010-6233663, +86-010-62332515</td>
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</table>
**Apparatus:** Physisorption and Chemisorption Analyzer AUTOSORB-1C

**Function:**

Physisorption and Chemisorption Analyzer AUTOSORB-1C, made by Quantachrome Instruments company, America, is the most sophisticated powder specific surface area and porosity analyzer of the world at present.

- Dynamic state temperature programming (Flow TPR/TPD)
- Static pressure state temperature programming (Soak TPD)
- Vacuum state temperature programming (Vacuum TPD)
- Chemisorption isothermal curve
- Monolayer cover quantity
- Active (metal) dispersion degree (percentage) (particular function)
- Average microcrystallite dimension
- Adsorption heat
- Physical adsorption isothermal curve and distribution of micropore and mesoporous.

**Performance index:**

- 1 analysis station and 2 preparation station
- 5 path air inflow
- High temperature furnace (1100°C)
- Patent oil-free vacuum system
- 5 high-precision sensor and 1 liquid level sensor, vacuum degree is 10-10mbar (analysis station and degassing station)
- Superficial area range: 0.0005 - 5000 m²/g
- Pore volume: < 0.0001 cc/g
- Bore diameter: 3.5 - 500A (0.35 - 50 nm)

**Location:** Room 109, Metallurgical Building

**Operator:** Sun Gensheng

**Tel:** +86-010-82375799, +86-010-62332515
Apparatus: Atomic absorption spectrophotometer AA—6300, AA—6800

Function:
The equipment is provided with air—acetylene flame and graphite furnace, and can detect about 30 elements in soil, plant, steel and non-ferrous materials.
The floor level of air—acetylene flame testing method is 1mg/L, and of graphite furnace testing is 1µg/L.
Special element detecting method is determined by its value.

Location: Room 803, metallurgical building (AA—6300); 107 (AA—6800)
Operator n: Wang Lihua (AA—6300)
Tel: +86—010—62332786, +86—010—62332515
Operator: Sun Gensheng (AA—6800)
Tel: +86—010—82375799, +86—010—62332515

Apparatus: Inductively coupled plasma atomic emission spectroscopy (ICP—OES). OPTIMA 7000DV

Function:
Inductively coupled plasma atomic emission spectroscopy (ICP—OES, made by Perkinelmer, co—ltd America, is mainly used for semi—quantitative or quantitative analysis of impurity elements (main scale, microscale or trace scale). Based on solid detector, it is the full spectrum of direct reading plasma emission spectrometer, consists of radio—frequency generator, plasma, sample injection system, beam splitting system, detector, analysis software and computer system.

Performance index:
- Analysing rate: ≥10 elements/min, real time background correction;
- Dynamic range: ≥106 wavelength range: 160—900nm or all the wavelength including the above one;
- Background correction: contemporary background correction. background correction point is taken automatically or manauly;
- Distinguishability: ≤0.003nm (at 200nm)
- Stability: 1hour stability: RSD≤1.0%,4hour stability RSD<2.0%;
- Frequency: 40.68MHZ;
- Power: 750W～1500W or more, 1W continous adjustable increment; Power stability: ≥ 0.1%;
- Optical path system: driving gas type, high-performance middle ladder grating two-dimensional
<table>
<thead>
<tr>
<th><strong>dispersion spectrometer system:</strong></th>
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**Location:** Room 107, Metallurgical Building  
**Operator:** Wang Lihua  
**Tel:** +86-010-62332786, +86-010-62332525

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<table>
<thead>
<tr>
<th><strong>Apparatus:</strong> O-N-H analyzer TCH600</th>
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**Function:**  
Microscale analysis of O, N, H inside solid sample (steel and inorganic substance)  
Standard sample weight: 1g  
Analysis scale:  
- **O:** 0.05 ppm ~ 5%  
- **N:** 0.05 ppm ~ 3%  
- **H:** 0.1 ppm ~ 0.25%  
Degree of accuracy:  
- **H:** 0.005 ppm or 2% RSD  
- **N:** 0.025 ppm or 0.5% RSD  
- **O:** 0.025 ppm or 0.5% RSD  
Analysis method:  
- **O, H:** non-scattering infrared absorption method  
- **N:** thermal conductance method

**Location:** Room 107, metallurgical building  
**Operator:** Han Lihui  
**Tel:** +86-010-62333014
**Apparatus:** C-S analyzer EMIA-820V

**Function:**
Microscale analysis of C and S inside solid sample (steel, slag and inorganic substance)

**Analysis range:**
- C: ~1ppm~6.0%
- S: ~1ppm~0.4%

**Analysis precision:**
- C: 0.3ppm or 0.5%RSD
- S: 0.3ppm or 0.5%RSD

**Location:** Room 107, Metallurgical Building

**Operator:** Zhang Mei

**Tel:** +86-010-62333474

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**Apparatus:**
Gas chromatography molecular mass spectrometry detector - GCMS_QP2010

**Function:**
It is used for the quantitative and qualitative analysis of solid and liquid phase of metallurgical production, on-line and off-line. Property of equipment at the level of national standard.

**Performance index:**
- New designed high-brightness ion gun, provided with low noise testing system, has improved S/N ratio and achieved ultrahigh sensitivity. Strong (QA/QC) function and GLP supporting function.
- Mass scale: 1.5~1090 m/z;
- Resolution ratio R≥2M(FWHM);
- Maximum scanning speed 10000amu/s;
- Sensitivity: Scan 1pg S/N≥185 E1, standard sample OFN、SIM 100fg S/N≥185 m/z=272;
- Double enter pot turbomolecular pump differential motion system, Vacuum di speed >360L/S.

**Location:** Room 107, metallurgical building

**Operator:** Feng Gensheng; Yu Chunmei

**Tel:** +86-010-62333014
**Apparatus:** Infrared spectrometer & infrared microscope

**Function:**

Infrared spectrometer & infrared microscope, made by Nicolet corporation, America, is mainly used for analysis molecular structure of functional group. The infrared spectrum wavelenth range of FTIR is $350 - 7000\text{cm}^{-1}$, which can be used in infrared spectrometry of spot, line and area analysis for sample surface. Infrared microscope is mainly used for analysing the microcell functional group and structure at $\mu$ level. It is provided with functions of automatic/manual operation, locating and focusing, etc, which can be used for the interchange of absorbance and transmittance.

**Location:** Room 109, Metallurgical Building

**Operator:** Zhang Yingfang

**Tel:** +86-010-82375842

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**Apparatus:** Water modeling system

**Function:**

1. Converter splash protection, flow behaviour of molten steel in Converter;
2. Flowability and miscibility of molten steel inside LF finery, AOD furnace, VOD furnace, CAS, etc;
3. Argon blast of steel ladle, tundish metallurgy, flow behaviour of molten steel in crystallizer;
4. Measurement of secondary cooling control system;

**Devices:**

1. Circulating water system: storage water tank, pipeline, flowmeter and flow control valves, etc.
2. Gas system: gasholder, gas pipeline, flowmeter, valves, etc.
3. Model: converter, LF finery, steel ladle, tundish, crystallizer, etc.
4. Measure and control instrument: conductivity meter, Siemens programmable logic controller (PLC) (metallurgical process automatic control simulation program), Wave Height Gauge, computer, Slice illuminant, digital camera, etc.

**Location:** Room 107 (underground), Metallurgical Building

**Operator:** Han Lihui

**Tel:** +86-010-62333014, +86-010-62332515
**Apparatus:** Analog system

**System constitution:**
1) Calculating software CFD: Fluent 6.3.26  
   CFX 11.0
2) Meshing software: ICEM CFD 11.0  
   Gambit 3.2.30
3) Hpworkstation and high allocated computer.

**Software instruction:**
CFX, developed by AEA company, England, and purchased by Ansys company, America, is a practical analysis tool for journal of fluids engineering. It is used for simulating the flow fluxion, heat transfer, multiphase flow, chemical reaction and combustion. It specializes in conducting the problems with sample flow physical phenomenon and complex geometry shape. The scope of application is: system of rectangular coordinates/cylindrical coordinate/rotated coordinate; Instant/Sliding Mesh; incompressible/slightly compressible/compressible flow; Buoyancy-driven flows; multiphase flow; non-Newtonian fluid; chemical reaction; combustion; Nox generation; radiation; porous media and multi heat transfer process.

FLUENT is one of the advanced CFD software in the world. It is widely used for simulating the fluid flow, heat transfer, combustion, pollutant migration and fuel cell, etc. The main function includes: importing grid model, providing physical model of calculation, inflicting boundary condition and property of material, solution and subsequent management. Grid forming softwares supported by FLUENT include GAMBIT, Tgrid, prePDF, GeoMESH and other CAD/CAE package.

**Location:** Room 107, Metallurgical Building

**Operator:** Han Lihui

**Tel:** +86-010-62332515, +86-010-62334991
**Apparatus:** Slag melting point and speed locator RTW-10

**Function:**
The melt materials property multifunction RTW-10 is mainly used for the analysis of viscosity, surface tension and density of high-temperature melt. The torque sensor is adopted to improve analysis precision and the data was collected and managed by computer automatically.

**Performance index:**
- Silicon carbide heating furnace;
  - Maximum working temperature 1450°C.
- Temperature control unit, PID computer program control
- Thermocouple: S type Single platinum rhodium.
- Temperature transmitter: Double wiring system, linearization, temperature autocompensation

**Location:** Room 108, Metallurgical Building

**Operator:** Du Chunrong

**Tel:** +86-010-82375169, +86-010-62332515
**Apparatus:** Melt materials property multifunction RTW-10

**Function:**
The melt materials property multifunction RTW-10 is mainly used for the analysis of viscosity, surface tension and density of high-temperature melt. The torque sensor is adopted to improve analysis precision and the data was collected and managed by computer automatically.

**Performance index:**
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- Temperature transmitter: Double wiring system, linearization, temperature autocompensation

**Location:** Room 108, Metallurgical Building
**Operator:** Du Chunrong
**Tel:** +86-010-82375169, +86-010-62332515
**Apparatus:** Iron ore performance analyzer

**Project:**
1) Reducibility measurement of iron ore at 900 ℃, according to ISO7215 standard. And the technological parameter in accordance with GB/T13241-91 standard.
2) Reduction degradation measurement of iron ore at low temperature, according to ISO7215 standard, and technological parameter in accordance with GB/T13241-91 standard.
3) Reductive inflation index of pellet measurement, according to ISO/DP4698 standard, and technological parameter in accordance with GB/T13241-91 standard.

**Device:**
- Reduction furnace ISO7215
- Standard reduction reaction tube ISO7215 (GH44)
- ES—20KA/0.1g electronic balance
- CO high temperature reforming furnace (1200 ℃)
- KTNJ10KW silicon controlled voltage regulator; ISO Low temperature pulverization drum device.
- Expansion index of Pellet reduction assay container (GH44 material)
- Computer data-processing system

**Location:** Room 108, Metallurgical Building
**Operator:** Feng Gensheng
**Tel:** +86-010-62334991, +86-010-62332515

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**Apparatus:** Coal powder property testing multifunction

**Function:**
Coal powder property testing multifunction CPBITI-II, developed by University of Science and Technology (USTB), is mainly used for testing the length of flame and fire point of exploded coal powder. It is widely used in teaching, researching and producing process. The equipment consists of industrial control computer, temperature controller and relative electric accessory, automating the process of warming; coal powder injection; ignition; residue clean and testing, recording and printing of flame length. It is a automatic analyzer of simple structure, stable performance and convenient operation.

**Performance index:**
1. Range of flame length: 0-800mm
2. Gauge length resolution ratio: 10mm
3. Coal powder injection rate: 1g
4. Temperature control area: 0-1600℃
   - Working temperature: 1100℃
   - Control accuracy: 1%
5. Fire point measurement:
   - Warming method: PWM, open cycle, warming upper limit: 600℃
   - Temperature resolution: +/- 1℃
   - Contour dimension: 2000x500x800mm + 600x500x1300mm
6. Weight: about 500Kg
7. Power dissipation: <3000W; power source: 220V single phase, 50Hz/60Hz
8. Working environment: 0-50℃, relative humidity <85% (non-moisture condensation),
   vibrationless, non-corrosiveness gas.

**Location:** Room 108, Metallurgical Building

**Operator:** Song Zhongping

**Tel:** +86-010-62333663, +86-010-62332515, +86-010-62334991

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**Apparatus & Performance index:**

1. Ultra-temperature tube furnace SKZ18—BLL
   - Maximum temperature: 1800℃
   - Hearth size (mm): Ø 70*100
   - Equal temperature length: ≤100mm
   - Atmosphere: oxidation/neutral/reduction atmosphere
   - Heating material: LaCrO3

2. Ultra-temperature tube/crucible dual-purpose furnace SGDZ16—BLL
   - Maximum temperature: 1650℃
   - Hearth size of tube furnace (mm): Ø 80*100
   - Heating material: MoSi2
   - Hearth size of crucible (mm): Ø 250*300
   - Equal temperature length: ≤100mm
   - Atmosphere: oxidation/neutral/reduction atmosphere

3. High temperature chamber oven SX13—BLL
   - Maximum temperature: 1350℃
   - Hearth size (mm): 150*100*120
   - Heating material: SiC
   - Hearth size (mm): 300*500*200
   - Equal temperature length: ≤100mm
   - Atmosphere: oxidation/neutral/reduction atmosphere

4. High-temperature tube furnace SKZ13—BLL
   - Maximum temperature: 1350℃~1600℃
   - Hearth size (mm): Ø 30*200
   - Equal temperature length: ≤100mm
   - Atmosphere: oxidation/neutral/reduction atmosphere
   - Heating material: SiC, MoSi2

**Electrothermal blowing dry box CS101—2EB**
Temperature range: 25℃—300℃
Chamber size (mm): 500*550*500
Argon arc welding machine and thermoelectric couple calibrating

Location: Room 108 (underground), Metallurgical Building
Operator: Zhang Ying
Tel: +86-010-62333597, +86-010-62332515

Apparatus: 10kg Vacuum induction furnace

Function:
10kg vacuum induction furnace and mating external electric field processing unit is mainly used on research of new metallurgical material, new process experiment, preparation of new materials, dephosphorization and desulfuration of metallurgical process, etc.

Performance index:
- Rated capacity: 10kg (steel)
- Normal rated: 60kW
- Final vacuum: 6.6×10⁻³Pa
- Working vacuum degree: 6.6×10⁻²Pa
- Vacuum system configuration:
  - KT-300 oil diffusion pump + 2X-30 mechanical pump
  - Multistation gating system
  - Electrode promotion and demotion system
  - Cooling water, gas connector
  - Raming system

Location: Workshop, Metallurgical Building
Operator: Wang Yugang
Tel: +86-010-62332248, +86-010-62332515
**Apparatus:** Electroslag furnace

**Function:**
Refined metal after electroslag process can reduce the content of nonmetal inclusion and its distribution and kernel. It also uses the crystallographic strong water cooling to improve the crystal structure and intensity of material.

**Performance index:**
- Transformer capacity 400KVA
- Working voltage: 30–49V
- Working current: 3000A
- Maximum capacity of crystallizer: 60Kg

**Location:** Work shop, Metallurgical Building
**Operator:** Cheng Boping
**Tel:** +86-010-62332394, +86-010-62332515

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**Apparatus:** Vacuum carbon tube furnace

**Function:**
The equipment consists of furnace body, bottom gearing, top vacuum semicontinuous charging system, vacuum machine set, water cooling system, transformer and electric control cabinet, etc. The multifunction vacuum carbon tube can be used at vacuum or antivacuum condition, and is used for metallurgy, physical chemistry, high-temperature metallurgy, high pure metal refining, slag action and inorganic nonmetal material sintering experiment, etc. It is the most advanced carbon tube furnace of China.

**Performance index:**
- Maximum working temperautre: 2300°C, common use temperautre: 1600°C – 1900°C, temperature programming;
- Silicon controlled pressure regulating, end vacuum: $1 \times 10^{-3}$ Pa, heating power: 72KW;
- Heater size $\Phi 156/140 \times 370$mm, vacuum charging;
- Bottom discharge and rotated crucible device, with rotational speed 20—200r/min, stepless speed regulating;

**Location:** Work shop, Metallurgical Building
**Operator:** Sun Gensheng
**Tel:** +86-010-82375799, +86-010-62332515
<table>
<thead>
<tr>
<th><strong>Apparatus:</strong> Multifunctional vacuum induction furnace</th>
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<tbody>
<tr>
<td><strong>Function:</strong> Multifunction vacuum induction furnace, made in England, is used for high temperature heat research, vacuum metallurgy and external refining. The nominal capacity is 25Kg. It can make and research on high-quality metal with electroslag furnace 400KVA.</td>
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<td><strong>Performance index:</strong></td>
<td>Vacuum melting and antivacuum melting</td>
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<td>Vacuum sampling, charging and ingot casting</td>
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<td>Vacuum degree is $2 \times 10^{-2}$torr</td>
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<td><strong>Location:</strong> Work shop, Metallurgical Building</td>
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<td><strong>Operator:</strong> Chen Boping</td>
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<th><strong>Apparatus:</strong> Iron ore powder sintering and pelletizing device</th>
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<td><strong>Function:</strong> The System is provided with φ 200 Sinter pot with the 500–700 mm height layer, and can work under different subatmospheric pressure, with different bed height of materials. It is provided with efficient lighting system. According to the high burning temperature and large temperature scale, it can be used for different firing temperature, firing intensity and hot gas sintering, etc. It has efficient blender mixer cask with adjustable rotate speed, filling ratio, and time, which can be used for simulating the mixing and pelletizing process of sintering experiment.</td>
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<td><strong>Location:</strong> Work shop, Metallurgical Building</td>
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<tr>
<td><strong>Responsible person:</strong> Feng Gensheng</td>
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<tr>
<td><strong>Tel:</strong> 62334991, 62332515</td>
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