

• Portrait

Kunming Institute of Precious Metals

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1. Introduction

Situated in Kunming, Yunnan Province, the institute is a scientific research organization with a history of fifty years. It is now affiliated with the China National Nonferrous Metals Industry Corporation.

At the beginning of the nineteen sixties, the institute commenced research work in the field of precious metals. It has since then developed and extended greatly, and its activities now cover various fields of precious metals science and technology, including the comprehensive utilization of precious metals resources, their separation and purification, reclamation and recovery from wastes, precision alloys and function materials, composites, chemical compounds and coordination compounds, thick film pastes for micro-electronics, catalysts, electroplating solutions and electroplates, analysis and testing, etc. and related applied and basic research. The institute has eight research departments and three pilot plants equipped with more than 300 sets of various sophisticated apparatus. With this relatively complete system, the institute in addition to extensive research and development, work outlined above, is also involved in the production of certain special precious metals and alloys.

During recent years, the institute has placed greater emphasis on practical applicability of research results in the development of national economy. Each year, it completes more than 200 items of national R and D projects, the results of which have served the national economy. During the 8 years from 1979 to 1987, 113 prizes were awarded by the China National Nonferrous Metals Industry Corporation and Yunnan Province. A series of national and corporation standards were drawn up by this institute for precious metal products.

Laboratory studies of a more basic nature are also carried on in the institute. Many such research results have formed the subjects for international academic exchanges. About 80 research reports and theses are published each year in domestic and international journals or as scientific and technical monographs. Appointed by related organizations, a number of special centres serving the whole country have been established in this institute including the research centre of precious metal anti-cancer medicine, China commodity inspection laboratory of imported and exported precious metal products, and the scientific and technological information network for precious metals.

2. Main Research Domain and Achievements

2.1 Comprehensive utilization of precious metals resources

(1) Comprehensive utilization of precious metals resources in Jinchuan: As early as 1960, the institute undertook the tasks of analysis and dressing tests for Cu-Ni sulfide ores in Jinchuan. A number of processes, including desulfurization by hot filtration, secondary electrolysis, hydrochlorination, and separation and purification of precious metals, were proposed after investigation, as a result, platinum, palladium and gold were produced in Jinchuan for the first time, thus setting up a basis of precious metals production in China. In the 70s, a new flow sheet of secondary sulphurization, grinding-flotation, selective leaching by hydrochloric acid, chlorination by controlled potential, distillation of Os and Ru, and separation and purification, was worked out, it increased significantly the recovery of precious metals and was put into production in 1981. The work "Investigation of the Process for Extraction of Precious Metals from Secondary Cu-Ni Alloy" won a first class National Scientific and Technical Progress Prize.

(2) Improvement of the processes of recovering precious metals from by-products

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of nonferrous metals metallurgical plants: The traditional pyrometallurgical technologies used in the treatment of anodic slimes from electrolysis of Cu and Pb have the disadvantages of lower recovery of precious metals and environment pollution. In the 70s, a new hydrometallurgical process for treating anodic slimes from electrolysis of Cu was proposed by this institute and tested with success in several small and medium refineries. The recoveries of Au and Ag increased by about 26 and 18% respectively. These new methods brought remarkable economic benefits and won a second class National Scientific and Technical Progress Prize. At present, another novel hydrometallurgical flow sheet for treating anodic slime of Sn and Pb and extracting Au by cementation with Zn in gold mines has met with success and is about to go into production.

(3) Comprehensive utilization of low grade resources of precious metals: For the treatment of certain low grade Pt-bearing ores with a high magnesium content, a process comprising (a) blast furnace smelting to produce calcium magnesium phosphate fertilizer, (b) blowing, electrolyzing and separating the P-Ni-Fe to recover Pt, Pd, Cu and Ni, was adopted. With a higher recovery of precious metals, better economy and comprehensive utilization of all the valuable elements in the ore, this process opened up a new approach for the treatment of low grade precious metals-bearing ores.

2.2 Investigations on the recovery of precious metals from waste materials

(1) In 1964, a study on extraction of Pt and Rh from catalytic wire gauze used in the nitric acid industry was completed with only 0.1% loss of the metals, and won a prize of the National Scientific Conference. A process for the recovery of platinum group metals from oxidation furnace ashes from the nitric acid industry was also developed with only a 0.1% loss of these metals in the residues. Both of these processes have been put into production and have produced a considerable economic benefits.

(2) In cooperation with Yaohua Glassworks, Shanghai, a process for the recovery of Pt and Rh from the used refractory bricks in glass fiber industry was completed, which lowers the concentrations of Rh and Pt in the waste liquid to less than 0.01% and produces no tailing and residue. This study won a third class National Invention Prize.

(3) A series of novel technological processes for the recovery of precious metals from a variety of other waste materials, such as alloy scraps, spent catalysts, waste liquids and residues, have been suggested and mastered by institute.

2.3 Development of precious metal alloys

Since the time work was started in the field of precious metals, the institute has developed a series of important alloy materials, some of which attained or closely approached the world's top level in properties.

(1) Resistance materials and strain gauge materials: A series of low, medium and high resistance materials with a resistivity of 12-200 $\mu\Omega\cdot\text{cm}$ have been developed. These include platinum-based, palladium-based and gold-based alloy wires, from 0.02 to 0.008 mm in diameter.

The institute supplies platinum-tungsten strain gauge wires of various specifications, the finest of which is 0.008 mm in diameter. Some high temperature strain gauge materials are in use in dynamic stress measurements at 1000°C and static stress measurements at 800°C. They have high strength and excellent stability under high temperature, small temperature coefficient of resistance and large coefficient of sensitivity.

(2) Electrical contact materials: In this area, contact, brush and conduction ring materials made of platinum-, palladium-, gold-, silver-based alloys and composite materials have been developed. Among them alloys of gold-and silver-rare earth metals win great popularity by virtue of their low and stable contact resistance,



Fig.1 A glimpse of institute

excellent arc-extinguishing ability and negligible metal migration, as well as a durable life.

(3) **Thermometrical materials:** Precious metal thermometrical materials for temperatures ranging from 0.2 K to 2400K are studied by the institute. These include high purity platinum wires and a variety of thermocouple wires. High purity platinum wires used for standard and industrial platinum resistance thermometers and platinum electrodes for thermocouples are physically pure to the extent of $W_{100}=1.385$, $W_{100}>1.3920$ and $W_{100}>1.3926$ in accordance with IPTS-68. Pt-10Rh/Pt, Pt-13Rh/Pt, Pt-30Rh/Pt-6Rh thermocouples are supplied in accordance with IEC standards.

(4) **Other materials:** Other precious metal materials include spring and magnetic materials, ball-bonding gold wires, crucible and bushing plate materials for the optical and fibre glass industry, iridium crucibles made by a unique method, brazing and soldering materials, and so on.

(5) The pilot plants of this institute supply various products in the form of wires, plates, tubes, foils, layered-composite and composite rivet, etc., 230 varieties of alloys with over 2000 specifications. These materials are being extensively used in many departments and factories in China.

2.4 Research and development of thick film pastes for micro-electronics

These include conductive pastes, electrode pastes, resistance pastes and dielectric pastes. The low temperature silver paste, gold pastes for fine wires, Au-Pd, Ag-Pd, Ag-Au-Pd electrode pastes, pastes for high voltage and high resistance etc. Pastes

have been developed to attain the same level of properties as the 7941, 9260, 9500 and 9400 series, made in America. In present years, researchers of the institute are studying multi-layered thick film paste systems and have established a paste pilot plant.

2.5 Precious metal chemical products

A broad research program in chemical compounds of precious metals is underway. The institute is now able to offer various compounds and complexes, such as oxides, chlorides, chloro acid complexes and their salts, nitrite complexes, ammine complexes, etc., of precious metals. These find very diversified uses as chemical reagents, and are also used in the preparation of other derivatives, various supported catalysts and electroplating solutions. In the field of anti-cancer medicines, the synthesis technology of "cisplatin" has been improved, its purity and production scale increased. In another anti-cancer medicine "carboplatin", significant progress has also been made.

Another program is for catalysts. Development of catalysts for the purification of exhaust gases from gasoline and diesel engines has met with success.

2.6 Precious metals electroplating

We have mastered various precious metal electroplating techniques, particularly those for bright electroplating. The institute has developed electroplating solutions of Au, Ag, Pt, Pd, Rh, Ir and certain alloys, suitable for use in many fields. Our rhodium electroplating solution is comparable to the most advanced products on the international market, and can be used for either industrial or decorative purposes.

2.7 High purity precious metals and ultra-fine powders

The highest purity of Pt and Pd obtained at this institute is >99.999%, with (by analysis) 13 impurity elements for Pt and 11 impurity elements for Pd. The highest purity of Ir and Rh is >99.99% and 99.995%, with 14 and 13 impurity elements, respectively.

The average particle size of high purity gold, silver, palladium and platinum powder is <0.5 μm . Palladium-oxide, ruthenium-dioxide and iridium-dioxide powder with an average particle size of less than 1 μm can also be supplied. These powders are extensively used in the electronic industry.

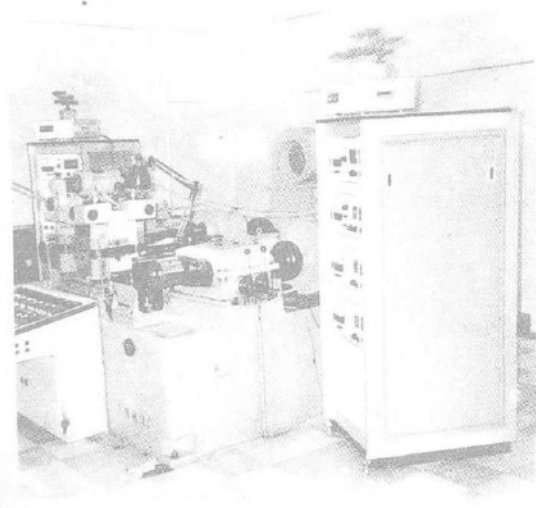


Fig.2 A 20-roll finish rolling mill

2.8 Rapidly solidified metals

Work in this field deals mainly with the preparation of novel alloys by the use of rapid solidification processing (RSP) technology. It consists of the development of techniques for synthesizing new alloys, followed by extensive studies of electrical, mechanical and thermal properties etc. on these materials. Such new materials include microcrystal, quasi-crystal and metallic glasses based on Pd, Pt, Cu, Ti, Mo and other elements. Related research is concerned with forming conditions of metallic glasses and their thermal stability, structure relaxation and crystallization dynamics. In another program, the metastable extension of solid solubility of Ag based

alloys prepared by RSP was studied systematically. A series of theses have been published in domestic and international journals and reported on the fourth, fifth and sixth International Conference on Rapidly Solidified Metals.

In the past 30 years or so, the Kunming Institute of Precious Metals has made important contributions in the development of the precious metal industry and in raising the related scientific and technical level in China. From now on, the institute will endeavor to make greater contribution to the development of the Chinese nonferrous metal industry, and to promote economic construction of Yunnan Province.