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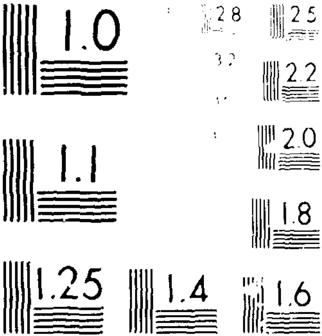

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A BRIEF INTRODUCTION OF THE INSTITUTE OF METAL RESEARCH, ACADEMIA SINICA, SHENYANG*

by

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The Institute of Metal research was built from scratch in 1951, Shortly after the founding of the People's Republic of China and was formally established in 1953. At the beginning, the Institute was assigned the task of solving problems confronted with the development of the iron and steel industry. The Institute is situated in Shenyang of Liaoning Province in the north-eastern part of China. Shenyang is one of the largest industrial cities in China, and famous in machinery industries. Not far away from Shenyang, there are several iron and steel plants. Anshan Iron and Steel Cooperation the largest one up to now in our country is only less than one hundred kilometers away from Shenyang. This was the main reason for which the Institute was established there. We did some works on mineral dressing, process metallurgy, mechanical working, refractory materials as well as metal physics and physical metallurgy during the first few years after its establishment. For instance, we developed alumina magnesia spinel bricks for the open hearth furnaces instead of the conventional chrome bricks, because Liaoning is rich in magnesia and poor in chrome ore. We helped the factories established the techniques used for quality control of steel, etc.

Since 1958, instead of directly serving the iron and steel industry, the Institute was changed to the development of new materials. In line with this, relevant new technologies, new processes and methods of testing were also established.

At present, we have more than 600 technical staff, of which about 70 are in the rank of senior engineers, research associate professors and research professors, 400 are university graduates. There are about 50 graduate students who are now studying their master and doctor degrees in the Institute. There are 17 scientific and technological departments altogether, and can be classified into four categories.

The first category is those who are mainly dealing with basic research. They have free choice of their research problems without restriction so long as their subjects are in the frontier of metal physics or physical metallurgy. There are two departments belonging to this category. One is headed by Professor T. S. Ke, the inventor of torsion pendulum used for measuring internal friction of metals. The other department is headed by Professor K.H.Kuo. a foreign member of Swedish Academy of Engineering Sciences. The main works of the first department are concentrated on the defects and mechanical properties of metals, especially on internal friction and fatigue of metals, influence of electron and phonon processes on deformation and fracture of metals. For the second department, most of their effort will be concentrated on lattice images of crystals; some works are on structure of amorphous metals and alloys, structure of adsorped substances on metal surfaces and X-ray analysis of texture of metals and oxides.

The second category is applied research concerning application and development of materials. During past twenty years, we worked on alloy steels, superalloys, refractory metals, titanium and its alloys, pyrolytic graphite, ceramics, etc. for a long time. From now on our background will be stressed on materials for energy systems and problems related with the effective utilization of national natural resources. For instance, we are undertaking a programme to develope some type of blade material used in industrial gas turbine working at more corrrosive medium; to develope some material with better abrasion and cavitation resisting properties used for hydro-electricity generator blades; to solve the material problems for coal gasification and liquefaction equipments. We are also studying materials for high energy density batteries, as intercalation compounds, and for hydrogen storage, as $LaNi_5$, etc. All the materials mentioned above are very critical to the effective use of the national resources as well as to establish new energy systems.

China is very rich in rare earth metal resources, but application in metallurgy is rather limited; and therefore we were assigned to study the behavior of rare earth metals in steel-making as well as to find some new applications. We systematically studied the behaviors of formation of inclusions because rare earth metals are supposed to be one type of the most effective scavengers in steel bath. We also have a group who are studying phase diagrams, one of their goals is to find some new rare earth metal containing compounds with peculiar properties.

Due to scarcity of chromium and nickel in China, more than twenty years ago we started working on the systems of Fe-Mn-Al and Fe-Cr-Mn-N for a long period of time. It had been proved that some austenitic steels from Fe-Mn-Al system could be used as heat resisting, cryogenic and non-magnetic steels which were comparable to or even superior than chromium-nickel containing austenitic steels except corrosion resisting property which is equivalent to plain carbon or low alloy high strength steels at room temperature. The oxidation property is rather good due to presence of about 4% aluminum. A two-phase Fe-Cr-Mn-N stainless steel was developed, it showed an excellent corrosion resisting property in urea medium than chromium-nickel stainless steels 316L.

In line with material development, we are now carrying out some applied basic research works as following:

First is the mechanical properties related to the microstructures of metals. We are studying the mechanical properties of the materials both fundamentally and simulating the working conditions. Such as crack initiation and propagation during fatiguing, creep-fatigue interaction at high temperatures, in air or in a corrosive medium.

Second is hydrogen in metals. Hydrogen is an ideal secondary energy and it is present in many chemical engineering processes. But hydrogen can cause deterioration of metals, and this may limit the application of metals in the manufacture of hydrogen-containing equipments. This is one of the reasons why it is a very active field at present. We have a rather large group of research workers doing various aspects of the field.

Third is corrosion, wear, erosion, abrasion and cavitation of metals, all the properties are closely related to surface science which is one of our main basic research projects.

Fourth is solidification of metals, including amorphous and microfine grained metals due to rapid cooling. In connection with the production of superalloy castings, we studied the porosity formation as well as directional growth, etc.

The third catigory is processes and material engineering. Different processes both for experimental and for engineering purposes are provided to exploit appropriate performance of the material and insure its proper applications. For instance, we have different types of smelting equipments, as vacuum induction furnaces, consuming electrode remelting furnaces, electro-slag remelting furnaces, electron beam remelting furnaces, etc. For mechanical working, we have rolling mills, swaging machines, extruding machine (600-ton vertical), spinning machine, etc. For castings, besides precision casting equipments, we have a die casting machine for liquid steel under vacuum, rheocasting and directional growth equipments, etc. For welding, we built the first high voltage electron beam welding equipment in our country, diffusion welding under high vacuum as well as plasma welding equipments has been established besides the conventional types of welding machines. We are now under construction of a two kilowatts laser welding equipment. Suface coating is the most effective and economical mehtod to protect metal from corrosion, wear, erosion and/or abrasion, we have provided many processes to do this, such as plasma spraying, diffusion coating, ion plating, etc.

The fourth category is some establishments of technical service, such as chemical analysis, phase isolation and analysis, microstructure analysis equipments(including optical microscopes, transmission electron microscopes, scanning electron microscopes, auger spectroscopy and electron micro-probe), mechnical property testing equipments (including programmable servo fatigue testing machine in addition to the many types of conventional testing machines), physical property measurement equipments, such as young's modulus, thermal conductivity, emissivity, etc. Some properties can be measured at a temperature as high as 3000°C, and now we are installing a helium liquefier which will be used as cooling medium for testing at much lower temperature.

In order to make full use of our superiorities, such as well-experienced scientists, various kinds of advanced equipments and multidisciplinary activities, we did many failure analyses for the industry during the past years, for example, pressure vessels, power equipments, etc.

From the above survey of the Institute, it can be drawn that the activities of the Institute are coupling within the field of materials science and engineering, they are multidisciplinary and interdisciplinary. Therefore, it has been decided that the Institute will take materials science and engineering as its main research direction, although we do not study organic substances and only small fraction of non-metallic inorganic materials.

Institute of Metal Research is one of the well known research institutions in China, there have been hundreds of foreign scientists came to visit our Institute from developed countries in recent years. There have been six seminars sponsored by our Institute since we received the financial assistance from UNIDO for a Material Science Training Center in October, 1980, in addition to more lectures given by the transient visiting scholars, the seminars are:

1. Plastic deformation of metals and its physical metallurgy given by Professor Hugh J.. McQueen of Concordia University of Canada;
2. Superconducting materials, given by Dr. D. DuHughes of the Oxford University of England;
3. Modern metallography, given by a group of scientists, headed by Professor G. Petzow of Max-Planck-Institute, West Germany;
4. Electron beam remelting of metals, given by Dr. H. Stephan of Leyhold-Herans Co. of West Germany;
5. Rapid solidification of metals, given by Professor R. W. Cahn of the Sussex University in England;
6. Hydrogen in metals, given by a group of eight scientists headed by Professor G. Alefeld of Technical University of Munchen, West Germany.

The seminars lasted from one to two weeks, the number of participants were usually from thirty to sixty of which about half came from other institutions and factories of the country and another half were from our Institute. Most of the seminars were very successful and fruitful. For instance, optical metallographic techniques are very important for quality control of metallurgical products as well as a primary tool for metallurgical research. Through the seminar which consisted of lectures, experiments and modern metallographic equipments exhibitions (shipped by Buehler from USA and Leitz from West Germany), most of the participants were acquainted with the recent development. Rapid solidification of metals and hydrogen in metals are two of the most active fields in materials science, and these are also the principal fields of our Institute. The lecturers invited are mostly world leading scholars in their respective fields. All those who took part in the seminars sensed and experienced that such kinds of meetings would not only be helpful to research workers, but also beneficial to teachers, besides, we had very interesting and instructive discussions with the lecturers about our research projects, and we think all these would further promote mutual understandings.

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