On Study of New Progress and Application of Coordination Chemistry in Chemistry and Chemical Industry in Recent Years

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Abstract: Coordination chemistry refers to a branch of chemistry, and its research results are widely used in industry and people's daily life. Many edge disciplines emerge during the development, which propels the process of disciplines and technology. This paper briefly discusses new progress of coordination chemistry and its application in chemistry and chemical industry in recent years.

1. Introduction
The coordination chemistry refers to an interdisciplinary which develops based on the inorganic chemistry, the combination of coordination chemistry, organic chemistry and structural chemistry which is viewed as the opening of inorganic chemical revival. The establishment of coordination chemistry breaks boundaries in organic chemistry, inorganic chemistry and physical chemistry, and it becomes a joint point of different chemical branches. Coordination chemistry, because of different property, makes a certain achievement in scientific research and practical applications. It is one discipline which is the most active and boasts of more growth points.

2. Coordination Chemistry and Its Theories and Characteristics
The coordination chemistry refers to a discipline whose research objects are metal atoms, ions, inorganic and organic ions or coordination compounds characteristics obtained by the reaction in molecules and their bonding, structure, reaction, classification and preparation. In coordination compounds, the central atom combines with ligand through coordination bonds. Theories explaining coordination bounds are valence-bond theory, crystal-field theory and molecular orbital theory.

The characteristics of coordination chemistry are going into the micro level from the macro level. However what research focuses on is not only the macroscopic property of coordination compounds but also its microscopic property. It emphasizes the study on microstructure, such as the internal structures of molecule and atom, the law of electronic operation, and their behaviors. The chemical structure theory system is established based on modern chemical bond theory on this basis. Coordination chemistry is equipped with experimental data and theoretical basis and it turns from qualitative description to quantitative direction. Modern coordination chemistry commonly adopts mathematical methods and theories including group theory, vector analysis, linear algebra, topology and mathematical physics. It also adopts many computers in calculation. It conducts mathematical process to amount of physical and chemical properties of reaction structure information. It combines data processing with highly accurate and sensitive quantitative tests in order reach a new level of coordination compound research [1]. The results shall be more accurate and differentiation occurs when
it tends to integration at the same time. On the one hand, modern coordination chemistry accelerates differentiation and on the hand, it mutually penetrates and integrates with different disciplines, bringing about a lot of emerging edge disciplines.

3. Analysis of Research Fields and Application of Modern Coordination Chemistry

Modern coordination chemistry includes seven research fields, such as supramolecular chemistry, transition metal organic complex, complex catalysis, nanometer materials, and bio-coordination chemistry. The supramolecular chemistry, as a systems science, refers to supramolecule with a specific functional structure formed by chemical substances through function of component force. The function of force refers to the force between molecules, or it can be described as a functional system of science formed by molecules through covalent bond. Serving as an interdisciplinary, it covers the chemistry, physics and other fields and closely related to development of macrocyclic chemistry. It is even can be said in a sense that supramolecular chemistry combines the four basic chemistries together. The goal for supramolecular chemical is to study the assembly and its process and to form supramolecular functional system through assembly in order to imitate nature and achieve innovation and development, and its function can be compared with natural systems. The assembly is usually achieved by organization and assembly by virtue of the template effect. The research significance to metal cluster complexes is shown in excellent catalytic performance, and some of them boast of special magnetic or electrical properties. Some organic ligands boast of specific biological activity and are models for studying other substances. Because of particularity, it is significant to research the chemical bond of metal atom compound.

The application of coordination chemistry; the coordination chemistry is applied earlier and the application involves in many aspects in life, especially the field of heavy industry and natural sciences, such as biochemistry, semiconductors, electroplating and analytical chemistry. The application in traditional aspects includes analytical chemistry, such as indicators, medical, drugs, wet metallurgy, metal separation for purification and catalysis. In terms of human life activities, the complex is significantly important, and metals in living body are existed in the form of complexes. The trace elements which have been proved beneficial to human body are oxygen, carbon, hydrogen, nitrogen, calcium, phosphorus, potassium, sulfur, sodium, chlorine and magnesium. Most of them are existed with the form of complexes with a special physiological function. While in medical clinic, drugs commonly used will display their biological effects after combining the metal ions in human body. Some drugs are toxic in treatment because of their strong irritation. The nonabsorbent feature makes some drugs inapplicable directly in clinic, and such drugs must be transformed into coordination compounds in order to reduce toxicity and irritation. The ligand may also be used as an antidote. People will be allergic when overdose metal elements are inhaled. Some properties of ligand can be used to expel metal ions in human body through replacing metal ions with ligands. The earliest antidote is dimercaprolum which can be used as antidote for mercury, arsenic and other metal poisoning. It can form a water-soluble complex after combining with metal ions, so the toxicity can be eliminated and it excretes out. The rare earth complex luminescent materials are widely used and can be used for color blindness studies as well as fluorescence analysis of biological macromolecule.

Coordination chemistry is widely used in chemical industry and is especially unique in the
chemistry and chemical industry. Most heavy metals in water exist in the form of complexes and the reason is that organic and inorganic ligands are contained in water. However, the situation is complicated for the former which includes natural degradation products, sugar, and amino acids of animals and plants. The ligand is more complicated as a result of discharge of living and industrial wastewater. People realize that there is a close relationship between transfer and transformation of heavy metals and ligand when studying a series of laws of pollutants in water including migration, reaction, and influence. The combination of complex with water replaces the water-insoluble metal complex with a soluble metal complex. The ligand in waste water is able to melt the metal in the reaction and influence. The combination of complex with water replaces the water-insoluble metal heavy metals and ligand when studying a series of laws of pollutants in water including migration, wastewater. People realize that there is a close relationship between transfer and transformation of heavy metals and ligand when studying a series of laws of pollutants in water including migration, reaction, and influence. The combination of complex with water replaces the water-insoluble metal complex with a soluble metal complex. The ligand in waste water is able to melt the metal in the reaction and influence. The combination of complex with water replaces the water-insoluble metal heavy metals and ligand when studying a series of laws of pollutants in water including migration, wastewater. People realize that there is a close relationship between transfer and transformation of heavy metals and ligand when studying a series of laws of pollutants in water including migration, reaction, and influence. The combination of complex with water replaces the water-insoluble metal complex with a soluble metal complex. The ligand in waste water is able to melt the metal in the reaction and influence. The combination of complex with water replaces the water-insoluble metal heavy metals and ligand when studying a series of laws of pollutants in water including migration, wastewater.

4. Emergence and Development of Coordination Chemistry

The first record of complex is Prussian blue, which was discovered and used as a pigment as early as 18th century and its chemical formula is K[Fe(CN)₆].

Cobalt and other complexes were found in 19th century whose chemical formulas and coordination theories were proposed by Swiss scientists. The secondary valence concept was also introduced.

The year 1923 saw British chemists reveal the relationships between ligancy and the number of electron atomic in center by using EAN. In order to determine whether the complex is stable, one has to consider the relationships between effective atomic number and the central atoms with gas atomic numbers in same cycle. This law is not universal for it is just applicable in some complexes. After more than ten years, the American chemists put forward the valence bond theory, so the nature of complex is clearly understood. The theory is easily accepted because it is specific in model and clear in concept, so it is able to react to the general appearance of complexes, and to roughly explain properties of complexes. However, there are still shortcomings for this concept as it only qualitatively interprets the properties of complexes and the discussion is merely about basic properties. Two scientists research CFT which, as a theory, discusses division of central orbital in the quasi-electrostatic field on the basis of electrostatic theory. The theory sees great development in later days. One shortcoming for this theory is that the model is too simple to explain the effect of cloud-expanding. In later days, scientists introduce molecular orbital theory into the study of complex chemical bond. The coordination field theory refers to combining crystal field and molecular orbital theory in order to study complexes. The theory holds that the ligand in bonding and metal atom orbit should be treated equally and it preserves crystal field theoretical model, convenient for calculation. This theory is widely used in studying properties and structures complexes. The coordination chemistry witnesses vigorous development after the establishment of valence bond theory, molecular orbital theory and quantum theory.

Crystal engineering is an important aspect in supramolecular chemistry research, and its concept was proposed in the 1960s. The 1980s saw progress in experimental technology, and scientists further studies functions among molecules. In 1980s, people gradually accepted the fact that crystal exists as a supramolecule based on a series of research results, and therefore it becomes the mainstream topic to research crystal in supramolecular chemistry. While crystal engineering has become an important form of supramolecular synthesis whose chemists discover supramolecular compounds by virtue of different methods, however, it is not easy to effectively determine supramolecular architecture in solution. Molecular crystals can be regarded as assembly by countless molecules according to periods. The structure can be determined by X-rays, and conclusions can be drawn by measuring a large number of crystals. The solid structure in surface area can be used as a model of solution system and coordination solid supramolecules serves an important part in crystal engineering. In order to better analyze the intermolecular interactions, one can simplify identified features through supramolecular synthesis. The crystal engineering acts principles and methods of supramolecular chemistry on crystal indirectly by
virtue of functions of molecular accumulation and interaction. From the macroscopic point of view, the studies about crystal theory are profound gradually and are widely applied in molecular materials, identification, and devices day by day. The crystal engineering has become a synthetic strategy for the formation of new materials such as light and electro-ion exchange. Serving as a boundary science, it has involved in organic and inorganic chemistry, thermochemistry, crystallography and other traditional areas.

The study about development of coordination chemistry was nearly empty before the founding of new China. After the founding of this country and with the recovery and development of national economy, some scientific research units and individual units began studies on coordination chemistry. In the mid-1960s and even earlier, what the coordination chemistry research focused on was property, structure and synthesis of complexes which were only simple complexes. The contents of the research work are concentrated in some high-yielding elements, mainly separation and purification in China. The research work includes solution equilibrium theory, the stability of mixed complexes and others. The content of scientific research work is relatively simple and smaller in scope, and there is still a gap to catch up with international standard.

After the reform and opening up, guided by relevant policies of the state, coordination chemistry research has developed rapidly and tremendous achievement is made; the year 1978 saw Nanjing University set up a research institute, and chemical association founded magazine in 1985, and the international conferences were opened in 1987 in support of relevant departments. A series of events and achievements have shown that China's coordination chemistry is developing rapidly and walking towards the world. In the later development, important progress has been made in some aspects, such as new complexes, thermodynamic and kinetic studies, solution ion extraction and isotropic catalysis.

Achievement and development process made in China's coordination chemistry research reflect characteristics in many ways. In terms of research objects, they combine life and materials science together, and attach great importance to it and molecular design gradually. For instance the problem of metal ions bonding, partial boning is eliminated in vitamin B12 and the rest mostly combines with each other in the form of coordination bond. The composition of functional system is more complicated and it is necessary to place the correct species in corresponding positions in order to play its original functions. People attach great importance to supermolecule research such as synthesis and assembly. Although progress is made in coordination chemistry in China, we have to clearly realize that such study in a certain areas is still insufficient, and further effort should be made in follow up researches. Our research in coordination chemistry makes tremendous progress in combining coordination chemistry and related chemical branches, and coordination of chemistry is promising in application and potential in development.

5. Classification and Characteristics of Complexes
Ligand and metal ions are related to the stability of complexes. Moreover, the chelating effect also affects the stability, and there is a direct ration between chelating degree and the stability of complexes, which means the former increases, its corresponding stability also increases.

Organometallic compounds also are known as metal organic compounds, and many organometallic compounds exist with the form of complexes; metal atoms are sandwiched between two parallel carbon ring systems, known as sandwich compounds.

Many complexes can be made directly by their composition compounds through addition, and when there are different oxidation states in metal ions, the different valence metal complexes can be made through ligand and oxidized metal ion complexes function in oxidizing agents. The main reactions are acid-base reaction, substitution reaction, electron transfer reaction, chemical analysis and catalysis.

As for the preparation of cobalt hexachloride, one has to prepare solid NH4Cl, CoCl2•6H2O (C.P.), 6% H2O2(C.P.), 6 stronger ammonia water (C.P.), strong HCl solution (C.P.), 2mol / L HCl, ethanol (C.P.), activated carbon and ice, NH4Cl4g, 8ml H2O. 6gCoCl2 • 6H2O crystal, 0.3g activated carbon, 14ml concentrated aqueous ammonia and 14ml6% H2O2 solution, and after a series of reactions, the
measurement calculation is conducted; according to the formula: $2\text{CoCl}_2 \cdot 6\text{H}_2\text{O} + 10\text{NH}_3 + 2\text{NH}_4\text{Cl} + \text{H}_2\text{O}_2 \rightleftharpoons 2[(\text{Co(NH}_3)_6]\text{Cl}_3 + 14\text{H}_2\text{O}$, the products’ quality theoretically is:

$$M = \frac{6.0 \times 267.5}{237.9} = 6.77 \text{ g}$$

6. Conclusions
Coordination chemistry has won close attention from scientific researchers who summarize its property laws and apply it in different fields by studying complexes, which promotes the continuous development of coordination chemistry. While with the continuous development of technology, the study on chemical research shall be further profound, which is significantly important for the application of coordination chemistry.

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