# CHIKASHIGE AND UNO-LABORATORIES.

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At the time of the foundation of the Chemical Research Institute in April 1927, the Chikashige-Laboratory was established as one of its branches.

At the same time, several investigations were begun under the guidance of Professor Masumi Chikashige, dealing with the scientific and industrial sides of metallography. The brief sketch given below begins with an outline of these investigations.

One of the most celebrated applications of modern science to a historical consideration of ancient civilization was made in the Laboratory by Professor Chikashige, who successfully attempted for the first time to re-examine ancient alchemy in the Far-East from the chemical and metallographical point of view. The results of this examination were published in his monograph, "Oriental Alchemy (1929)" (in Japanese) and "Alchemy and other Chemical Achievements of the Ancient Orient (1936)". Furthermore, to continue this examination, he conducted chemical and metallographical researches the results of which were reported in "The Composition of the Han Mirrors and their Reproduction" [Proc. Imp. Academy, **5**, 345 (1929)]. It was entirely due to the results of these researches that this Laboratory succeeded in reproducing some superior ancient Chinese mirrors. His investigation was also extended to various metallic wares formerly manufactured in Japan, but the results have not yet been published.

The contributions of Professor Chikashige, who was the first to notice the metallographical importance of the relation between the colour and microstructure of alloys, to the progress of the investigation during the earlier days of the Chemical Research Institute, were not restricted to the inquiry of ancient matters. A number of experiments in various fields of metallography were also made by Professer Chikashige and his co-workers.

A study of the condition regarding the distribution of the constituent metals in an alloy of two layers was carried out by Dr. Teruo Ashida, but the results of this have not been published. Moreover, several metallographical investigations were reported in the following publications: — "Thermal Reduction of Sulphur in a Hydrogen Atmosphere, applied to the Analysis of Iron and Steel" [Y. Yamanouchi: Anniversary Vol. dedicated to M. Chikashige (1930) III], "The Diffusion of Zink in Copper and its Alloys" [Y. Yamanouchi; Mem. Coll. Sci., Kyoto Imp. Univ., A, **15**, 67 (1932)] [Bull. chem. Soc. Japan, **52**, 651 (1931)] (in Japanese), "The Influence of the Other Metals on the Vaporization of Zinc from Brass" [Y. Yamanouchi & S. Hamada; Bull. chem. Soc. Japan, **52**, 668 (1931)], "On the Ternary Silver Alloys, I. The System of Silver, Copper and Zinc" [S. Ueno; Mem. Coll. Sci., Kyoto Imp. Univ., A, **12**, 347 (1926)], "On the Ternary Silver Alloys, II. The system of Silver, Aluminium and Zinc" [S. Ueno; ibid., A, **13**, 91 (1930)], "On the Relation between the Colours and the Microstructures of some Binary and Ternary Silver Alloys with Visible Rays" [S. Ueno; ibid., A, **3**, 141 (1930)], "On the Ternary Silver Alloys, III. The System of Silver, Copper and Aluminium" [S. Ueno; Anniversary Vol. dedicated to M. Chikashige 57 (1930)] and "On the Ternary Silver Alloys, IV. Mechanical Properties of Some Ternary Silver Alloys" [S. Ueno; ibid., 77].

It is to be noticed that the results of these researches enabled us to form a brass layer on the surface of copper or its alloys by the diffusion of vaporized zinc, on the one hand; while, on the other, they led to the discovery of a non-oxidable silver alloy excellent for coinage, as can be seen in the publications "A New Coinage Metal; Forgery detectable without Analysis" [M. Chikashige and S. Ueno; World Eng. Cong., Tokyo (1929)] and "Ternary Alloys of Silver, Zinc and Copper" [M. Chikashige and S. Ueno; Japanese Patent, No. 82259].

Not only those above mentioned, but the crystalline configuration of a so-called single crystal in some metals obtained by sublimation, together with the crystal structure of intermetallic compounds, were also examined with X-rays. The results of these X-ray examinations were published in the papers "On the Arrangements of the Micro-Crystals in Zinc and Cadmium obtained by Sublimation" [T. Yamamoto; Mem. Coll. Sci., Kyoto Imp. Univ., A, **11**, 34 (1928)] and "On the Crystal Structures of the Compounds formed in Sb-Cd Alloy" [M. Chikashige and T. Yamamoto; Anniversary Vol. dedicated to M.

Chikashige 195 (1930)].

In September 1930, Professor M. Chikashige, who celebrated his sixtieth birth-day, retired because of his seniority, and his pupil, Professor Denzô Uno, was appointed as his successor. At the same time the Chikashige-Laboratory ceased and in its place the Uno-Laboratory was established.

By introducing the dilatometric study, Professor D. Uno endeavoured with his co-workers to continue the investigations which had been begun by Professor M. Chikashige. So, the researches carried on in the Uno-Laboratory naturally bore a close relationship to those made in the Chikashige-Laboratory.

The diffusion between the structural elements of various alloys in the region of the solid solution, were examined in the newly established Laboratory. Especially with regard to copper-rich alloys, a precise argument was advanced as to the solid solubility of some metals in copper. The results of these researches were reported in "Investigation of the Solid Solubility of Alloys, I." [D. Uno, S. Yoshida and S. Katori; Rep. Chem. Res. Inst., Kyoto Imp. Univ., **3**, 152 (1933).] (in Japanese), "The Dilatometric Study of cast Copper-rich Bronze" [D. Uno, S. Katori and S. Fujii; Bull, chem. Soc. Japan, **10**, 397 (1935).] (in German), "On the Abnormal Phenomena in heating cast Copper-rich Sb-Cu Alloys" [Tanaka and M. Iio; Bull. chem. Soc. Japan, **56**, 1293 (1935).].

A number of experiments were also made in connection with the temper-hardening of several alloys. The results of these experiments were reported by the following papers; "Investigation on the Temper-Hardening of Alloys, (I)" [D. Uno and Y. Murakami; Rep. Chem. Res. Inst. Kyoto Imp. Univ., **4**, 4 (1934)] (in Japanese), "High Temper-Hardenable Aluminium Light-Alloys" (Kobalmin) [D. Uno and Y. Murakami; Rep. Sci. Soc. Japan, **9**, 98 (1934).] (in Japanese), "On the Temper-Hardened Structure of Cu-Al Light-Alloys containing Co" [T. Emura and S. Hayashi; Rep. Chem. Res. Inst. Kyoto Imp. Univ., **6**, 110 (1936).] (in Japanese) and "The Influence of Mg and Mn on the Temper-Hardened Structure of Cu-Al Light-Alloys containing Co" [T. Emura and S. Nakamura; ibid., **7**, (1937) (under publication)] (in Japanese). Beside those experiments, arguments were advanced in connection with the temper-hardening of some light-alloys belonging to Cu-Al system, aided by direct microscopic proof. The outline of the arguments was published in "The Relation between the Temper-

Hardening and the Micro-structure of Light-Alloys belonging to Cu-Al System" [D. Uno and Y. Murakami; Rep. Chem. Rec. Inst. Kyoto Imp. Univ., **4**, 16 (1934).] (in Japanese) and "The Microscopic Study of Temper-Hardening of Light-Alloys belonging to Cu-Al system" [D. Uno and Y. Murakami; J. Chem. Ind., **37**, 403 (1934).] (in Japanese).

Some temper-hardenable alloys have been invented in this Laboratory, as were reported in "Aluminium Light-Alloys" [D. Uno and Y. Murakami; Japanese Pat., No. 107400], "High Temper-Hardenable Aluminium Alloys" [D. Uno and Y. Murakami; Japanese Pat., No. 106031], "High Age-Hardenable Aluminium Alloys" [D. Uno and Y. Murakami; Japanese Pat., No. 106032] and "On Cobalt German-Silver" [K. Tamura and S. Hayashi; Rep. Chem. Res. Inst., Kyoto Imp. Univ., **7**, (1937) (under publication)] (in Japanese), "Temper-Hardened Cobalt-Bronze" [D. Uno and S. Nakamura; Japanese Pat., No. 111701], "Temper-Hardenable Cobalt-Brass" [D. Uno and S. Hayashi; Japanese Pat., No. 112362], "Temper-Hardened Cobalt-Alloys" [D. Uno, S. Nakamura and S. Hayashi; Japanese Pat., No. 116908].

Not only that above stated, but additional research was carried out by means of X-rays under the guidance of Dr. Hideki Hirata, dealing with crystalline configurations in some electro-deposited metals. The results of these researches were published in the following papers; "On the Arrangements of Micro-Crystals in Copper and Gold deposited by Electrolysis" [H. Hirata and Y. Tanaka; Mem. Coll. Sci., Kyoto Imp. Univ., **15**, 9 (1932). Rep. Chem. Res. Inst., Kyoto Imp. Univ., **3**, 45 (1933)], "On the Direction of the Common Axis of Fibrous Arrangements formed by the Micro-Crystals in Electro-deposited Metals" [H. Hirata; Rep. Chem. Res. Inst., Kyoto Imp. Univ., **3**, 58 (1933)] (in Japanese). "Further Investigation of the Crystalline Structure of Electrolytic White Tin" [H. Hirata and Y. Tanaka; Mem. Coll. Sci., Kyoto Imp. Univ., **17**, 143 (1934).] and "On the Arrangements of the Micro-Crystals in Lead deposited by Electrolysis" [H. Hirata, Y. Tanaka and H. Komatsubara; Bull. Chem. Soc. Japan, **10**, 391 (1935)]. As a consequence of these researches with regard to the crystalline configuration of electro-deposited metals above mentioned, it can be expected to give one of the bases of the quantum mechanical arguments concerning the mechanism of the growth of crystals, which become fundamentally important to reconsider the theories of metallography, crystallography and electro-chemistry, in the terms of modern physics.

Furthermore, the X-ray investigation carried on in this Laboratory,

was extended to the study of silumin structure, the results of which were published in "On Silumin-Structure" [H. Kotô; Rep. Chem. Res. Inst., Kyoto Imp. Univ., **5**, 104 (1935).] (in Japanese) and "On the Crystal Structure and Crystalline Configuration of the Normal and Modified Si-Al Alloys" [H. Kotô; Mem. Coll. Sci., Kyoto Imp. Univ., A, **18**, 17 (1935).]. These papers revised the theory of modification of silumin-structure arrived at up to that time.

Now, Professor D. Uno and co-workers endeavoured to bring purely scientific theory and its industrial and technological applications into a more intimate relationship. Their achievements in mentallographical investigation were naturally not restricted to those above stated. They succeeded in manufacturing various silver-wares, by finding some silver alloys which could be highly hardened by simple heat treatments. The procedure for obtaining these silver alloys was reported in the publications "Abnormal Phenomena in Heating some Silver-rich Al-Ag Alloys" [D. Uno and S. Yoshida; J. Chem. Ind., **36**, 503 (1933).] (in Japanese), "Temper-Hardened Silver Alloys" [D. Uno and S. Yoshida; Japanese Pat., No. 104732]. New methode for plating the beautiful alloys used in ancient Japan, such as Shakudo (the dark-blue or deep violet gold alloy) and Shibuichi (the olive-greenish or fine grayish silver alloy), on the surface of copper and its alloys by diffusion were also invented. These inventions were reported in "New Methods in Producing Shakudo and Shibuichi" [D. Uno and K. Tamura; Rep. Chem. Res. Inst., Kyoto Imp. Univ., **5**, 119 (1935).] (in Japanese), "The Colouring Methods for Shakudo plated upon Copper or its Alloys" [D. Uno and K. Tamura; Japanese Pat., No. 106714] and "The Colouring Methods for Shibuichi plated upon Copper or its Alloys" [D. Uno and K. Tamura; Japanese Pat., No. 106715], and they enabled the Laboratory in producing various metallic wares of ever-bright and beautiful outview, as were made of genuine noble Shakudo or Shibuichi.