On the Reflective Power of Some Eutectic Alloys in Relation to their Micro-Structures.

By

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(Received December 13, 1927)

I Introduction

To establish the relation between the reflective power of some alloys and their micro-structures is one of the most interesting and important problems, both from the theoretical point of view of the atomic or molecular construction of alloys and from the practical point of view of their colours. Despite the numerous investigations on the reflective power of several metallic elements and the alloys of definite compositions by Rubens and others, there is, as far as we know, none with respect to a system of alloys except those made by Professor Chikashige[1], in which he has succeeded in measuring the reflective power of several systems of alloys with respect to their micro-structures. We have, therefore, at the suggestion of Professor Chikashige, undertaken the present investigation, thereby confining the subject to the case of the binary eutectic alloys.

II Experimental method

According to Schwarzschild, there exist under a normal exposure the following relation with respect to the opacity:

$$D=AIT^{k} \qquad (1)$$

or

$$\log D=A+\log I+K\log T \qquad (2)$$

1 Zeit. f. Anorg. Chemie, **124**, 335 (1922); **194**, 334 (1926).

where D is the darkness produced by the light of the intensity I, exposed T seconds, and A and K are constants relating to the nature of the dry plate. The darkness in this relation is, we may add, equal to the logarithm of relative opacity, that is, the reciprocal value of relative transparencies measured by the transmitted rays of a monochromatic light through the unexposed and exposed position on the plate.

Keeping the time of exposure as a constant, if the opacities D and D' of the incident and reflected rays be known, we have the following relation for the reflective power R :—

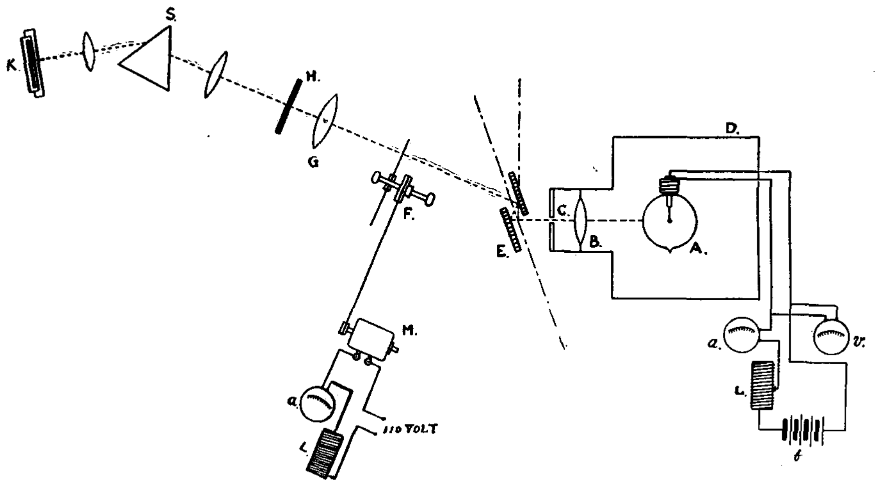
$$R=\frac{I}{I'}=\frac{D}{D'} \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Owing however to the difficulty of taking accurate measurements of them, we have not made use of the relative opacities but taken the times of exposure T and T' to produce the darkness D and D' with the light intensity I, so that we have

$$R=\frac{I}{I'}=\frac{D}{D'}=\left(\frac{T}{T'}\right) \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Our measurement relates therefore to the reflective power in terms of exposure with a knowledge of the characteristic constant K of a plate.

Fig. 1



The method of experiments runs as follows :—

The measuring arrangements, which have here in Professor Chikashige's laboratory hitherto been used, were slightly modified; it is as shown in Fig. 1, where A is a tungsten single filament lamp (8 volt ×

3 amperes), B a convex lens, which has its focus exactly at D, C a dark box, D a slit, E parallel mounted metallic sections, F a sector, G a concave lens forming an image of D at H, H the slit of the spectroscope, S a prism, and K a dry plate.

The light of a tungsten-lamp was, on the one hand, reflected twice by the polished surfaces of two samples placed parallel, the reflected light being dispersed by a prism and then photographed on a dry plate; while, on the other hand, the light coming directly from the light source, was dispersed by a prism and photographed on the same plate. The opacities of these two photograms were compared in the position of selected wave lengths corresponding with the seven visible colours measured in the Listing scale. The exact position of the spectra are to be known by reference to the annexed photos of the hydrogen and the mercury spectra.

In order to keep the light intensity constant for 3 to 4 hours, four accumulators were used, the current being adjusted to $\frac{1}{25}$ ampere. The incident ray kept an angle of 20° against the metallic section. The use of a collimating lens between D and E was thought unnecessary for the purpose of avoiding dispersion of the light from a slit D. The time of exposure was adjusted by a rotating sector F in which the aperture could be regulated to the exactness of 2°. The breadth of a slit H was kept as small as possible, so that the effect of the passing ray might be definite, as if a monochromatic light were used. The opacity was measured by means of Hartmann's micro-photometer in terms of its special scale. To express this scale in terms of the aperture, another standard "Wedge" was made, using a light source of constant intensity, with the aid of a sector belonging to the micro-photometer.

The darkness of the new scale was measured in terms of Hartmann's; the curve for calibration was drawn with photometric reading as abscissa and the angles of the sector as ordinate as shown in Fig. 4. By the use of this figure and of the relation (4), the reflective power may easily be calculated. As regards the measurement of the value of the constant K, the details will be given in Parag. 4, Section 4.

The Schwarzschild's formula necessitates our having the experiment carried on under a normal exposure. As log D and log T stand in a linear relation (2), the limit of exposure of the applied plate could however be known as described in Parag. 4, Section 1, by the use of an Ilford special rapid panchromatic plate exposed for several different times to a light having a constant intensity and developed, its darkness being then determined by a thermopile. The result is represented in Fig. 3, from which the limit of the normal exposure of the plate is easily to be measured.

With a constant time of exposure, only a small range of the spectrum is liable to come into the limit of the normal exposure of the plate, and hence in order to have the reflective power measured for a wide range of the visible spectrum, it was necessary to take the photogram repeatedly with different appropriate times of exposure. This was however done, instead of changing the time, by changing the aperture of a sector at a constant time, as it was believed to be more advisable in avoiding personal errors in observation. The reflective power thus measured is the product of a two-fold reflection; the square root of the number must therefore be the real value sought.

III Preparation of the Sample, Polishing, Structure of the Polished surface, and Effect of Crystallizing Direction and Polarization

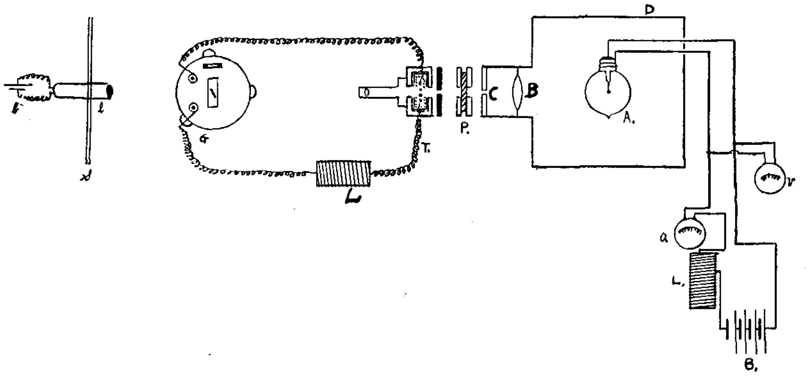
Melted alloys were furnace-cooled or sand-cast as the case might require. They were then annealed for 1–2 hours at a temperature 50°–100° lower than their solidifying points.

For the measurement of the reflective power of a sample, it is desirable that the polished surface should have an optical plane giving no scattering effect, but this is by no means a very convenient procedure by reason of its costing too much in labour and money. We, therefore, used an ordinary surface, except in a few cases, where we used an optical plane almost showing the linear flange of Newton's ring, whose number was less than six in the dimensions of the sample 20 mm $\times$ 15 mm. However, it was proved, at last, that neither result differs much from the other, as the experimental data afterwards given will show.

Whether the polished surface and the interior of a metal are different or not from each other in its structure, has hitherto often been a matter of discussion. Our experimental results incline rather to confirm, as may be seen from the numerical Tables given below, the opinion that both the surface and the interior are substantially the same.

Under the consideration that the crystallizing direction may have some influence upon the reflective power, several alloys consisting of fine crystals comparable to the breadth of the slit, from which the middle parts only were used as sample, were prepared. Several points near the middle of the samples examined did not show any difference in their reflective powers, indicating that the crystallizing direction affects the

Fig. 2



reflection in no appreciable manner.

Lastly, the effect of the polarization has been neglected as not introducing any serious error in our experimental result.

IV Preliminary Experiments

(1) Determination of the Limit of Normal Exposure

If we could keep I constant in equation (2), it becomes a linear function,

$$\log D = A' + K \log T.$$

As this relation holds good only for a limited time of exposure, it is necessary, at first, to determine the range of time for the normal exposure. Availing ourselves of a sector, accessory to Hartmann's apparatus, we made for ourselves a photographic "Wedge," using a dry plate of the same kind as used throughout this investigation, and measured the light intensities transmitted through the exposed and unexposed positions on the "Wedge" by means of a thermopile of bismuth and antimony in terms of the deflection of Broker's galvanometer with the light source of a constant intensity.

The apparatus of measuring is shown in Fig. 2, where A is a light source, B a convex lens, C a slit in the dark box D, P a dry plate, T a thermopile, G a Broker's galvanometer, and L a rheostat.

The ratio of eht two values of the exposed positions to the unexposed is a reciprocal of its relative transparency, *i.e.* relative opacity.

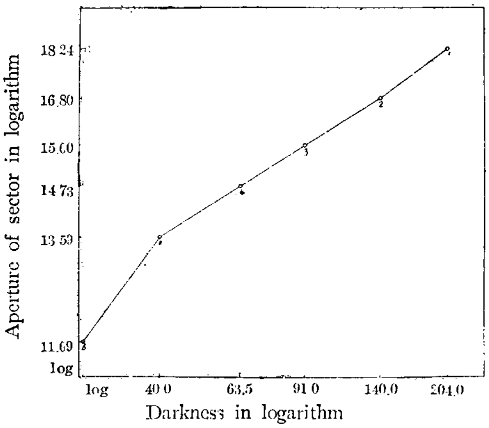
Experimental data are shown in Table I and represented graphically as in Fig. 3, from which it is evident, that the limit of normal exposure

Table I

Fixed position on a dry plate	Aperture of the sector at a corresponding position	Deflection of the galvanometer	Relative opacity
1	204·0	4·55	18·24
2	140·0	4·94	16·80
3	91·0	5·32	15·60
4	63·5	5·63	14·73
5	40·0	6·14	13·59
6	25·7	7·10	11·69
unexposed position	0	8·30	

falls between the photographic positions 2 and 5.

Fig. 3



The transmitted ray which passes through the "Wedge" includes the infra-red, but as its effect is inconsiderable, the relative opacity measured by the use of a thermopile can be held as tolerably accurate. The following experiment stands for this conclusion :—

The intensities of light cast directly upon a thermopile and that of the transmitted ray passing through the unexposed position on the "Wedge" were measured by means of a thermopile. These values are 12·2 and 3·6 in terms of the deflection of the galvanometer, showing that the infra-red is mostly absorbed by the glass plate and the gelatine film of the "Wedge."

(2) Calibration of the Scale of Hartmann's Photometer

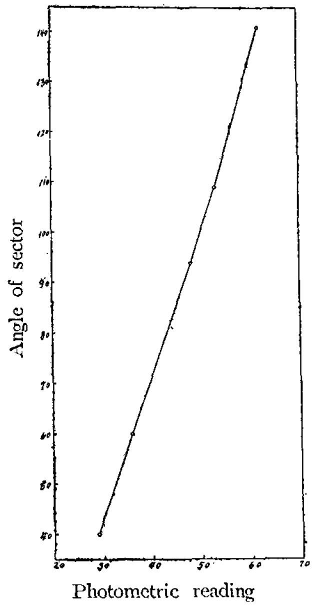
As the scale of Hartmann's photometer is an equidistant one referred to a standard, its reading has no physical significance. In order to have this scale calibrated in terms of the time of exposure of a constant light intensity, it was compared with the darkness of the same "Wedge" as was used in our determination of the normal exposure. So, we had the photometer's scale calibrated in terms of the aperture of the sector corresponding to the time of exposure in the limit of normal exposure.

The results of the experiments are as follows :—

Table II

Photometric reading	Aperture of the sector
29·0	40·0
36·0	60·0
48·0	94·0
53·0	109·0
62·0	141·0

Fig. 4



These values are graphically represented as in Fig. 4 and from the graph are deduced the data given in Tab. III.

Table III

Photometric reading	Aperture of the sector	Photometric reading	Aperture of the sector	Photometric reading	Aperture of the sector
		49·5	98·18		
		49·0	96·83	36·0	60·00
63·0	145·2	48·5	95·28	35·5	58·88
62·5	144·2	48·0	94·00	35·0	58·01
62·0	141·0	47·5	92·69	34·5	56·82
61·5	138·7	47·0	91·41	34·0	55·59
61·0	136·8	46·5	89·74	33·5	54·52
60·5	134·9	46·0	88·11	33·0	53·33
60·0	132·9	45·5	86·30	32·5	51·88
59·5	131·2	45·0	84·72	32·0	50·58

59·0	128·8	44·5	83·17	31·5	49·49
58·5	127·3	44·0	81·85	31·0	47·75
58·0	125·6	43·5	80·26	30·5	46·08
57·5	123·9	43·0	78·88	30·0	44·32
57·0	122·5	42·5	77·09	29·5	42·36
56·5	121·0	42·0	75·68	29·0	40·00
56·0	118·6	41·5	74·30		
55·5	117·0	41·0	72·94		
55·0	115·0	40·5	71·61		
54·5	113·5	40·0	70·47		
54·0	112·2	39·5	69·18		
53·5	110·4	39·0	67·61		
53·0	109·0	38·5	66·37		
52·5	107·4	38·0	65·16		
52·0	106·2	37·5	63·66		
51·5	104·5	37·0	62·52		
51·0	102·6	36·5	61·37		
50·5	101·0				
50·0	99·54				

(3) Determination of the Wave-Length of a Spectrum developed on a plate

The line spectra of mercury and hydrogen were first photographed upon an Ilford special rapid panchromatic plate, using the same spectroscope as in the case of the measurement of reflective power. The characteristic lines were chosen and their positions were fixed in terms of the scale of Hartmann's photometer. The results are shown in Table IV.

Table IV

Spectrum	Wave length in Å	Position on the dry plate in mm
Hydrogen	6563	199·0
〃	4861	190·3
〃	4341	184·7
Mercury	5461	194·3
〃	4047	171·3

From the graph (Fig. 5) representing the relation between the wave-lengths and the positions on the plate, we can easily determine the positions on the plate of the wave-lengths corresponding to the middle lines of the seven colours of the Listing scale. As to the red colour, however, the C line of the hydrogen spectrum was availed, the above graph not being used. The result is given in Table V.

Fig. 5

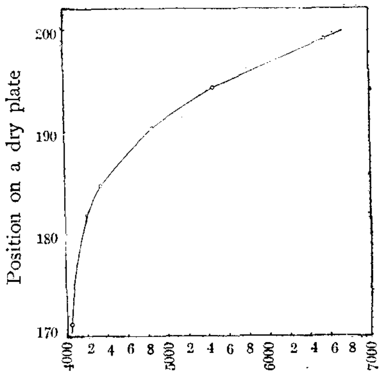


Table V

Wave length of the middle line of each of the seven colours in Listing scale in Å		Position on a dry plate in mm	Distance between two wave lengths in mm
Red	6563	190·0	0
Orange	6160	197·9	1·1
Yellow	5800	196·0	1·9
Green	5335	193·6	2·4
Blue	4735	189·2	4·4
Indigo	4395	185·3	3·9
Violet	4105	176·5	8·8

(4) Determination of the Characteristic Constant K of a dry Plate

From the Schwarzschild formula we have

$$\frac{D}{D'}=\frac{I}{I'} \quad \text{at a constant time of exposure,}$$

$$=\left(\frac{T}{T'}\right)^k \quad \text{at a constant intensity.}$$

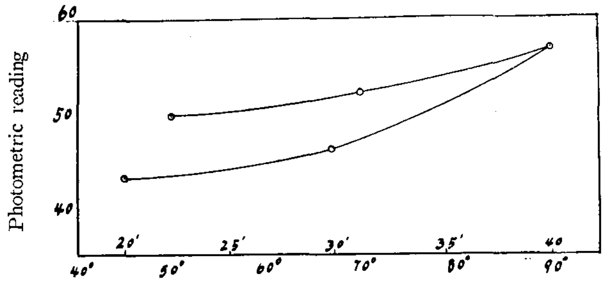
If we use a Nichol prism to regulate the light intensity, the tangent of the rotation angle of the prism is proportional to the light intensity, so that we have $\frac{I}{I'}=\frac{\tan a}{\tan a'}=\left(\frac{T}{T'}\right)^k$, where a and a' are the angles of rotation of the Nichol prism.

Then we have

$$K=\frac{\log \tan a-\log \tan a'}{\log T-\log T'} \quad \text{.................} \quad (4)$$

Applying equation (4) in order to determine K, the two series of determinations about a relation between the darkness and the time of exposure at a constant intensity, and that between the darkness and the intensity at a constant time of exposure were made :—these results are given in Table VI and graphically represented in Fig. 6.

Fig. 6



Above line......Angle of rotation of the Nichol ; under......Time of exposure

Table VI

Photometric reading	Angle of rotation of the Nichol prism	Time of exposure in seconds
43·2	90·0°	20
49·2	90·0°	30
56·7	90·0°	40
52·1	70·0°	40
49·9	50·0°	40

From any two of the photometric readings, their corresponding times of exposure and the angles of rotation of the Nichol, we can calculate K according to relation (4). For example :—

Table VII

Photometric reading	Angle of rotation of the Nichol prism	Time of exposure in seconds
55·0	82·0°	37·8
50·0	53·5°	31·5

The value of K is 0·91.

(5) Effect of the Velocity of Rotation of a Metallic Sector upon the Value of the Darkness of a Plate

The number of rotations would theoretically have no effect upon the intensity of the light, that is, the darkness of the plate. This fact is proved by taking photograms of the light with changing velocities of rotation of a metallic sector and by measuring their darkness on the plate. The number of rotations of a sector were 1150, 910 and 710 per minute. The resulting darkness of the plate measured by Hartmann's photometer was then almost equal to each other, the differences being within ±0·1 in the photometer reading.

(6) Constancy of the Intensity of the Light Source

During three hours, which was the time required for one course of our experiments, several photograms of the light source were taken, the darknesses of which were measured by the photometer in the same manner as before; the deviation of photometric readings was then found always to be within ±0·1. We may therefore safely conclude that there was no appreciable change of intensity during a single course of the experiment.

(7) Effect of the Application of a Collimating Lens in the Determination of the Reflective Power

For the measurement of the reflective power, whether the application of a collimating lens between a slit *C* and the sample *E* (Fig. 1) acts to prevent or not the diversion of the ray from the light source was not certain. So, the reflective power of pure silver was tested for a light of different wave lengths, 6563–4735 Å, with and without a collimating lens. The result indicated that there was no effect upon the values of the reflective power, as shown in the following Tables VIII and IX.

Table VIII

Without a collimating lens

Wave length	6563	6160	5800	5335	4735
Photometric reading with direct exposure	56·4	55·2	55·4	53·6	49·2
Aperture of the sector deduced from Fig. 4	120·53	115·80	116·60	110·76	97·37
Photometric reading with reflected ray of silver	53·5	48·9	47·6	45·2	41·5
Aperture of the sector deduced from Fig. 4	110·40	96·52	92·99	85·22	74·32
Reflective power after two-fold reflection	91·60	83·34	79·71	76·82	76·31
Reflective power	95·71%	91·30%	89·28%	87·70%	87·36%

Table IX

With a collimating lens

Wave-length	6563	6160	5800	5335	4735
Photometric reading with direct exposure	47·0	45·9	46·1	44·8	41·3
Aperture of the sector deduced from Fig. 4	91·41	87·75	88·43	84·10	73·75
Photometric reading with reflected ray of silver	44·7	41·1	40·0	37·9	34·3
Aperture of the sector deduced from Fig. 4.	83·76	73·21	70·47	64·77	56·32
Reflective power after two-fold reflection	91·67	83·43	79·68	77·02	76·37
Reflective power	95·75%	81·34%	89·27%	87·76%	87·40%

(8) Regulation of the Intensity of the Light Source

When a sample has a low reflective power, it is impossible to insure that the darkness in photograms of the incident and the reflected rays fall into the limit of the normal exposure with the same time of exposure, and therefore we must have recourse to changing the intensity of the light source by use of the "Wedge." Before use, this "Wedge" was naturally tested for the ability of having the same absorption of the light along the range of the visible spectrum, *i.e.* whether it has a neutral tint or not. Several photograms of the spectrum were therefore taken for this purpose, using different positions on the "Wedge" in a constant time of exposure. From these values of the darkness the aperture of the sector was measured. The ratio of these values at 6563 Å to any other wave-lengths was calculated. The following example may show how the absorbing power of a "Wedge" was determined.

Table X.

Fixed position on the "Wedge"		(7)
Photometric reading		61·0
Aperture of the sector deduced from Fig. 4	t	136·80
Fixed position on the "Wedge"		(4)
Photometric reading		45·9
Aperture of the sector deduced from Fig. 4	t'	87·91
Ratio of absorption power	$\left(\frac{t'}{t}\right)^K$	66·87

The ratio of absorption of the different positions on the applied "Wedge" is as follows :—

Table XI

Position on the "Wedge"	4/7	4/6	2/7	III/VII	II/VII	I/VII
Ratio of absorption	66·87	78·17	43.86			
〃				14·75	12.18	8·43

As may be seen from the following Table, the ratios are almost the same, notwithstanding the change of positions on the "Wedge" or omitting the "Wedge." The applied "Wedge" has therefore a neutral tint.

Table XII

Wave length	6563	6160	8500	5335	4735
Fixed position on the "Wedge"	(2)	(2)	(2)	(2)	(2)
Photometric reading with direct exposure	53·8	52·4	52·6	50·9	46·6
Aperture of the sector deduced from Fig. 4	111.48	107·16	107·72	102·28	90·07
Ratio of the aperture of the sector to that of 6563 Å		96·19%	96·69%	91·40%	80·80%
Fixed position on the "Wedge"	(4)	(4)	(4)	(4)	(4)
Photometric reading with direct exposure	56·8	55·6	55·8	54·0	49·6
Aperture of the sector deduced from Fig. 4	121·90	117·32	117·96	112·20	98·49
Ratio of the aperture of the sector to that of 6563 Å		96·24%	96·77%	92·00%	80·80%
Fixed position on the "Wedge"	(6)	(6)	(6)	(6)	(6)
Photometric reading with direct exposure	58·7	57·1	57·5	55·6	51·6
Aperture of the sector deduced from Fig. 4	127·90	122·78	123·90	117·32	104·84
Ratio of the aperture of the sector to that of 6563 Å		96·00%	96·87%	91·73%	80·87%
Fixed position on the "Wedge"	(7)	(7)	(7)	(7)	(7)
Photometric reading with direct exposure	61·0	59.6	59·9	58·0	53·5
Aperture of the sector deduced from Fig. 4	136·80	131·56	132·56	124·60	110·40
Ratio of the aperture of the sector to that of 6563 Å		96·18%	96·92%	91·88%	80·72%
Photometric reading with direct exposure	56·4	55·2	55·4	53·6	49·2
Aperture of the sector deduced from Fig. 4	120·52	115·80	116·60	110·76	97·37
Ratio of the aperture of the sector to that of 6563 Å		96·1%	96·8%	91·9%	80·8%

The absorbing power of a "Wedge" cannot however be maintained constant for a long period, so that another set was necessary to be kept as a reserve.

(9) The Exactness of the Measurement of the Reflective Power.

The experimental error of the reading of Hartmann's photometer was always within ± 0·1 %, so that the calculated error of the reflective power must be within ± 0·2 %.

By comparing the values of our determination of the reflective power of pure silver and of copper to those obtained by interpolation of Hagen and Rubens's results, we see there exists no much deviation as the following Tables will show :—

Table XIII
Reflective Power of Silver

Wave length	6563	6160	5800	5335	4735	4395	4105
Hagen and Ruben	96·3%	91·2%	89·3%	87·9%	87·4%	85·4%	82·1%
The investigator	95·71%	91·30%	89·28%	87·70%	87·36%	85·88%	82·02%

Table XIV
Reflective Power of Copper

Wave length	6563	6160	5800	5335	4735	4395	4105
Hagen and Ruben	80·4%	74·6%	62·5%	46·7%	40·3%	35·6%	31·3%
The investigator	82·79%	75·65%	63·20%	43·30%	42·76%	40·31%	

(10) Influence of the Mode of Casting upon the Reflective Power of the Alloys

Five samples of the silver and copper eutectic were made in the following different ways :—

Sample a : Cast in an iron mould
" b : Cast in a sand mould at a temperature of 200°
" c : Cast in a sand mould at a temperature of 100°
" d : Annealed at 650° for 3 hours
" e : Quenched at 650°

These samples were polished and etched with a 5% ferric chloride solution. They showed no blow holes under a microscope of 520 times magnification. Their reflective powers determined are tabulated as follows :—

Table XV

Reflective Power

Wave length	6563	6160	5800	5335	4735	4395
Sample a	72·94%	71·13%	69·57%	65·30%	62·50%	53·85%
〃 b	81·65%	79·58%	77·76%	73·29%	69·98%	59·85%
〃 c	80·80%	78·67%	76·79%	77·21%	69·31%	59·13%
〃 d	81·80%	79·66%	77·86%	73·26%	70·05%	59·97%
〃 e	72·18%	70·21%	68·73%	64·72%	61·77%	55·33%

Table XVI

Sample a

Wave length	6563	6160	5800	5335	4735	4395
Photometric reading with direct exposure	58·7	56·7	57·7	55·8	50·3	58·0
Aperture of the sector deduced from Fig. 4	127·30	121·30	124·24	117·96	100·41	125·60
Position on the "Wedge"	4	4	4	4	4	4
Photometric reading of the sample	56·2	51·8	51·7	45·65	38·8	36·2
Aperture of the sector deduced from Fig. 4	119·48	105·27	105·10	86·81	67·11	60·52
Position on the "Wedge"	7	7	7	7	7	7
Ratio of absorption	66·87	66·87	66·87	66·87	66·87	66·87
Reflective power after two-fold reflection	53·20	50·59	48·40	42·64	39·06	29·00
Reflective power	72·94	71·13	69·57	65·30	62·50	53·85

Sample b

Wave length	6563	6160	5800	5335	4735	4395
Photometric reading with direct exposure	55·8	56·7	57·7	55·8	50·3	58·0
Aperture of the sector deduced from Fig. 4	118·03	121·30	124·24	117·96	100·41	125·60
Position on the "Wedge"	4	4	4	4	4	4
Photometric reading of the sample	62·15	60·45	59·5	53·9	45·4	42·3
Aperture of the sector deduced from Fig. 4	141·94	134·71	131·15	111·88	86·04	76·32
Position on the "Wedge"	7	7	7	7	7	7
Ratio of absorption	66·87	66·87	66·87	66·87	66·87	66·87
Reflective power after two-fold reflection	66·66	63·33	60·86	53·71	48·97	35·82
Reflective power	81·65	79·58	77·76	73·29	69·98	59·85

Sample c

Wave length	6563	6160	5800	5335	4735	4395
Photometric reading with direct exposure	55·8	56·7	57·7	55·8	50·3	58·0
Aperture of the sector deduced from Fig. 4	118·03	121·30	124·24	117·96	100·41	125·60
Position on the "Wedge"	4	4	4	4	4	4
Photometric reading of the sample	61·5	59·55	59·4	52·8	41·6	41·5
Aperture of the sector deduced from Fig. 4	138·71	131·39	130·56	108·45	74·66	74·31
Position on the "Wedge"	7	7	7	7	7	7
Ratio of absorption	66·87	66·87	66·87	66·87	66·87	66·87
Reflective power after two-fold reflection	65·28	61·89	58·96	52·21	43·04	34·96
Reflective power	80·80	78·67	76·79	72·26	69·31	59·13

Sample d

Wave-length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	56·4	55·2	55·4	53·6	49·2	56·5	59·7
Aperture of the sector deduced from Fig. 4	120·52	115·80	116·60	110·76	97·37	121·00	131·88
Position on the "Wedge"							4
Photometric reading of the sample	49·2	46·0	44·9	39·9	34·4	31·4	30·4
Aperture of the sector deduced from Fig. 4	97·33	88·20	84·48	70·07	56·62	49·37	46·28
Position on the "Wedge"							7
Ratio of absorption							66·87
Reflective power after two-fold reflection	66·92	63·46	60·63	53·60	49·64	35·96	21·71
Reflective power	81·80	79·66	77·86	73·21	70·05	59·97	46·60

Sample e

Wave-length	6563	6160	5800	5335	4735	4395
Photometric reading with direct exposure	58·5	56·7	57·7	55·8	50·3	58·0
Aperture of the sector deduced from Fig. 4	127·30	121·30	124·24	117·96	100·41	125·60
Position on the "Wedge"	4	4	4	4	4	4
Photometric reading of the sample	55·4	50·9	50·9	45·1	37·5	35·7
Aperture of the sector deduced from Fig. 4	116·77	102·30	102·31	85·11	63·76	59·25
Position on the "Wedge"	7	7	7	7	7	7
Ratio of absorption	66·87	66·87	66·87	66·87	66·87	66·87
Reflective power after two-fold reflection	52·10	49·29	47·24	41·88	38·15	28·45
Reflective power	72·18	70·21	68.73	64·72	61·77	53·33

The reflective powers of the samples d and b are equal and highest. Those of the other samples are lower and decrease in order from c, a to e, the order being kept precisely the same in all wave-lengths. From this fact that the effect of casting upon the reflective power is not specific, we may draw the following conclusion, that the lowering of the refleective power is certainly due to the scattering effect of some tiny blow holes which are not detectable under a microscope.

V The Results of the Experiments

(1) The System of Silver and Copper

This system has already been studied by Nosé[1]; our result comes only to verify his results in all respects. As for materials, silver with a fineness of 999·9 per mil and electrolytic copper of the finest quality were used. The metals, mixed in the required weight proportion, were melted in Tammann's porcelain tubes, and the melted alloys were cast each in a sand mould at a temperature of 200°, and annealed for 3 hours at 650°, while the pure silver and the copper were annealed at a temperature 100° and 150°, respectively, below their melting-points. During the process of the melting and annealing, the surface of the alloys was always covered with charcoal powder under a current of carbon dioxide to prevent oxidation. Each sample was then polished first on emery paper, and then on a pitch plate with the aid of rouge. They were carried to a very high degree of ordinary hand polishing but not precisely to an optical plane.

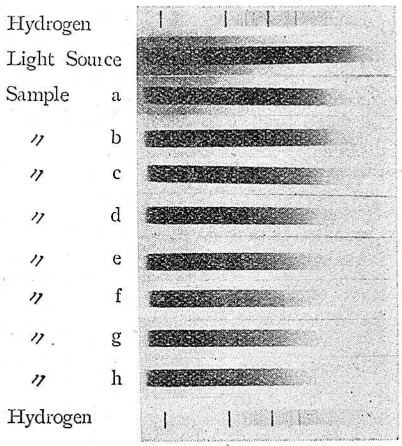
The samples examined had the following compositions :—

Table XVII
Composition of the Samples

No. of samples	a	b	c	d	e	f	g	h
Percentage of silver	0	2	15	28	50	80	90	100
Percentage of copper	100	98	85	72	50	20	10	0

The photograms of the spectra of the reflected rays, together with the spectrum of the light source, are given in Fig. 7. From the photographic plates was determined the percentage of reflective power in comparison with that of the direct light of an electric lamp regarded as 100. The results of examination are shown in Table XVIII for each sample and summarized in Table XIX.

Fig. 7.



1 Zeit. f. Anorg. Chemie, **154**, 344 (1926).

Table XVIII:—

Sample a

Wave-length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	50·6	53·25	55·4	53·6	49·2	56·5	59·0
Aperture of the sector deduced from Fig. 4	101·52	109·76	116·60	110·76	97·37	121·00	128·80
Position on the "Wedge"	—	—	—	—	—	—	—
Photometric reading of the sample	59·2	61·45	54·7	51·4	46·8	52·9	51·5
Aperture of the sector deduced from Fig. 4	129·45	138·56	114·01	104·08	90·83	108·62	104·62
Position on the "Wedge"	—	—	—	—	—	—	—
Ratio of absorption	—	—	—	—	—	—	—
Reflective power after two-fold reflection	91·60	83·34	79·71	76·82	76·31	73·68	67·28
Reflective power	95·71	91·30	89·28	87·70	87·36	85·88	82·02

Sample b

Wave-length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	50·6	55·2	55·4	53·6	49·2	56·5	59·0
Aperture of the sector deduced from Fig. 4.	101·52	115·80	116·60	110·76	97·37	121·00	128·80
Position on the "Wedge"	—	—	—	—	—	—	—
Photometric reading of the sample	58·75	46·0	51·55	49·65	44·5	49·15	48·15
Aperture of the sector deduced from Fig. 4.	127·99	106·22	104·76	98·58	83·08	97·20	94·34
Position on the "Wedge"	—	—	—	—	—	—	—
Ratio of absorption	—	—	—	—	—	—	—
Reflective power after two-fold reflection	82·36	75·15	73·75	73·11	70·36	66·60	61·24
Reflective power	90·75	86 70	85·88	85·50	83·88	81·61	78·26

Sample c

Weve-length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	56·4	55·2	55·4	53·6	49·2	56·5	59·0
Aperture of the sector deduced from Fig. 4.	120·52	115·80	116·60	110·76	97·37	121·00	128·80
Position on the "Wedge"	—	—	—	—	—	—	—
Photometirc reading of the sample	49·2	46·0	46·0	39·9	34·4	45·6	44·55
Aperture of the sector deduced from Fig. 4.	97·33	88·20	84·48	70·07	56·62	86·75	83·35
Position on the "Wedge"	—	—	—	—	—	—	—
Ratio of absorption	—	—	—	—	—	—	—
Reflective power after two-fold reflection	66·92	63·46	60·63	53·60	49·64	60·05	54·71
Reflective powir	81·80	79·66	77·86	73·21	70·05	77·50	73·96

Sample d

Wave-length	6563	6160	5800	5335	4735	4395	4105
Photometric reading withdirect exposure	56·4	55·2	55·4	53·6	49·2	56·5	59·7
Aperture of the sector deduced from Fig. 4.	120·52	115·80	116·60	110·76	97·37	121·00	131·88
Position on the "Wedge"							4
Photometric reading of the sample	49·2	46·0	44·9	39·9	34·4	31·4	30·4
Aperture of the sector deduced from Fig. 4.	97·33	88·20	84·48	70·07	56·62	49·37	46·28
Position on the "Wedge"							7
Ratio of absorption							66·87
Reflective power after two-fold reflection	66·92	63·46	60·63	53·60	49·64	35·96	21·71
Reflective power	81·80	79·66	77·86	73·21	70·05	59·97	46·60

Sample e

Weve-length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	49·4	50·6	55·8	54·0	61·2	62·1	62·9
Aperture of the sector deduced from Fig. 4.	97·33	101·32	117·96	112·20	137·56	141·56	145·00
Position on the "Wedge"	4	4	4	4	4	3	3
Photometric reading of the sample	62·1	61·5	59·6	51·0	49·4	47·4	32·5
Aperture of the sector deduced from Fig. 4.	140·10	138·07	131·55	102·61	97·85	92·52	51·87
Position on the "Wedge"	7	7	7	7	7	7	7
Ratio of absorption	66·87	66·87	66·87	66·87	66·87	59·64	59·64
Reflective power after two-fold reflection	78·51	74·69	62·24	51·96	41·34	34·49	19·93
Reflective power	88·61	86·43	78·90	72·09	64·30	58·73	44·65

Sample f

Wave-length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	49·4	55·6	55·8	54·0	61·2	62·1	62·9
Aperure of the sector deduced from Fig. 4.	97·33	117·32	117·96	112·20	137·56	141·56	145·00
Position on the "Wedge"	4	4	4	4	4	3	3
Photometric reading of the sample	57·5	59·4	46·8	32·4	34·6	32·4	29·6
Aperture of the sector deduced from Fig. 4.	123·29	130·15	90·59	51·81	57·09	51·56	42·57
Position on the "Wedge"	6	6	6	6	7	7	7
Ratio of absorption	78·17	78·17	78·17	78·17	66·87	59·64	59·64
Reflective power after two-fold reflection	80·55	71·38	51·09	32·16	25·32	20·26	16·65
Reflective power	89·75	84·49	71·48	56·71	50·32	45·01	40·81

Sample g

Wave-length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	45·95	55·6	55·8	54·0	61·2	62·1	62·9
Aperture of the sector deduced from Fig. 4.	87·23	117·32	117·96	112·20	137·56	141·56	145·00
Position on the "Wedge"	4	4	4	4	4	2	2
Photometric reading of the sample	62·1	56·55	45·1	30·3	31·2	29·2	31·4
Aperture of the sector deduced from Fig. 4.	141·32	121·16	84·91	45·40	49·90	40·82	48·99
Position on the "Wedge"	6	6	6	6	7	7	7
Ratio of absorption	78·17	78·17	78·17	78·17	66·87	66·87	43·86
Reflective power after two-fold reflection	85·77	66·91	48·17	28·52	22·40	18·18	14·70
Reflective power	92·61	81·80	69·41	51·80	47·33	42·65	38·35

Sample h

Wave-length	6563	6160	5800	5335	4735	4395
Photometric reading with direct exposure	49·4	55·6	55·8	53·7	60·7	62·1
Aperture of the sector deduced from Fig. 4.	97·33	117·32	117·96	111·20	135·68	141·56
Position on the "Wedge"	4	4	4	3	3	3
Photometric reading of the sample	56·4	56·15	43·7	30·2	29·7	29·1
Aperture of the sector deduced from Fig. 4.	120·66	119·32	80·81	45·14	43·04	40·46
Position on the "Wedge"	7	7	7	7	7	7
Ratio of absorption	66·87	66·87	66·87	59·64	59·64	59·64
Reflective power after two-fold reflection	68·53	57·23	39·95	22·36	18·28	16·25
Reflective power	82·79	75·65	63·26	47·30	42·76	40·31

Table XIX

The Reflective Power of the System of Silver and Copper

Wave length	6563	6160	5800	5335	4735	4395	4105
Sample a	95·71%	91·30%	89·28%	87·70%	87·36%	85·88%	82·02%
〃 b	90·75%	86·70%	85·88%	85·50%	83·88%	81·61%	78·26%
〃 c	90·12%	83·08%	82·81%	82·42%	78·67%	77·50%	73·96%
〃 d	81·80%	79·66%	77·86%	73·21%	70·05%	59·97%	46·60%
〃 e	88·61%	86·43%	78·90%	72·09%	64·30%	58·73%	44·65%
〃 f	89·75%	84·49%	71·48%	56·71%	50·32%	45·01%	40·81%
〃 g	92·61%	81·80%	69·41%	51·80%	47·33%	42·65%	38·35%
〃 h	82·79%	75·65%	63·20%	47·30%	42·76%	40·31%	

The reflective power in reference to a single wave-length and that in reference to the composition are graphically, represented in Figs. 8 and 9 respectively, and the dimentional relation between these 3 factors

Fig. 8.

System of Ag–Cu

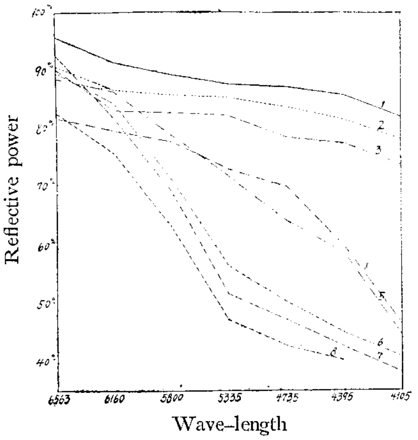


Fig. 9.

System of Ag–Cu

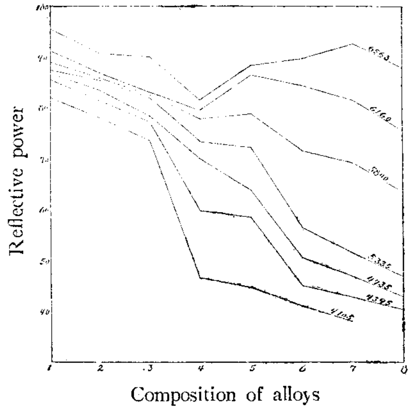
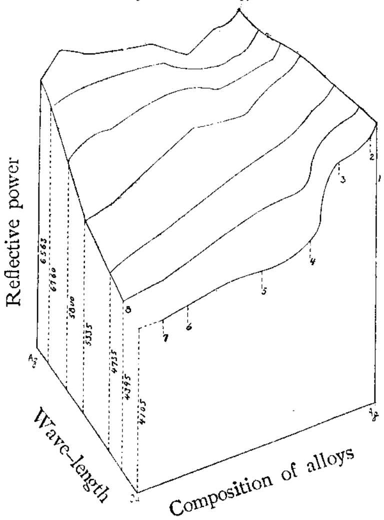


Fig. 10.

System of Ag–Cu



in Fig. 10. From these graphs, it is obvious that there exists a minimum point of reflective power between the wave-lengths 6563–5800 Å at the point corresponding to the eutectic. With wave-lengths shorter than 5800 Å, there is however no such minimum. The reason may be enunciated as follows :– Since the reflective power of pure copper decreases rapidly in the range of wave-lengths shorter than 5800 Å, that of the alloys having primary crystals of copper would be greatly influenced by the decreasing effect in the range of the shorter wave-lengths, as the result of which there would naturally be no minimum point observable at the eutectic point.

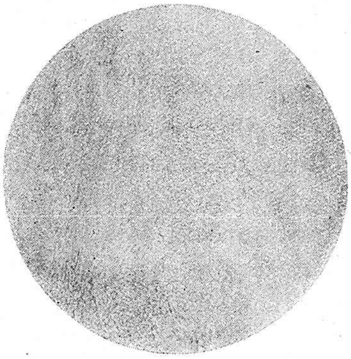
Whether the size of a crystal would have the same effect on the reflective power seemed necessary to be determined. The eutectic and 7 % Cu-alloys were tested for this purpose. In order to have the differences in the constituent crystal size made obvious, these alloys were treated in two ways, furnace-cooled and annealed; the following is the specification of the samples:—

Table XX

Samples	Kinds of alloys	Heat treatment
i	eutectic	furnace cooled
j	〃	annealed at 650° for 10 hours
k	7% Cu	furnace cooled
l	〃	annealed at 650° for 10 hours

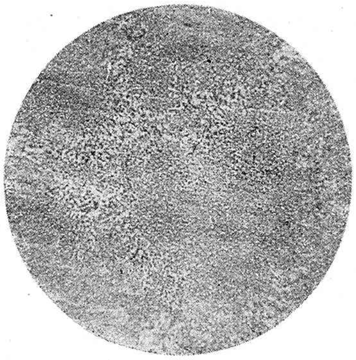
The polished surfaces of each sample were etched with *a* 5% solution of ferric chloride and examined microscopically.

Fig. 11.



Sample i ×390

Fig. 12.



Sample j ×390

Fig. 13.

Sample k ×390

Fig. 14.

Sample l ×390

The samples, furnace cooled, i and k, had much smaller crystals than the annealed j and l, as may be seen from the photographs, Figs. 11, 12, 13 and 14. The results of determination are given in Table XXI for each sample and summarized in Table XXII. From these results, we may conclude that the difference in size of crystals have no much effect on the reflection,

Table XXI

Sample i

Wave-length	6563	6160	5800	5535	4735	4395
Photometric reading with direct exposure	53·8	53·25	53·1	51·6	45·3	57·2
Aperture of the sector deduced from Fig. 4.	111·48	109·70	109·28	104·84	85·69	123·06
Position on the "Wedge"	4	4	4	4	4	4
Photometric reading of the sample	61·2	57·9	55·8	49·75	41·3	41·8
Aperture of the sector deduced from Fig. 4.	137·40	125·16	117·94	98·86	73·67	75·10
Position on the "Wedge"	7	7	7	7	7	7
Ratio of absorption	66·87	66·87	66·87	66 87	66·87	66·87
Reflective power after two-fold reflection	67·15	63·54	60·41	53·43	49·12	35·96
Reflective power	81·95	79·72	77·73	73·10	70·09	59·97

Sample j

Wave-length	6563	6160	5800	5335	4735	4395
Photometric reading with direct exposure	53·8	53·25	53·1	51·6	45·3	57·2
Aperture of the sector deduced from Fig. 4.	111·48	109·70	109·28	104·84	85·69	123·06
Position on the "Wedge"	4	4	4	4	4	4
Photometric reading of the sample	60·5	57·9	56·0	49·9	41·35	41·75
Aperture of the sector deduced from Fig. 4.	134·83	125·16	118·72	99·43	73·83	74·99
Position on the "Wedge"	7	7	7	7	7	7
Ratio of absorption	66·87	66·87	66·87	66·87	66·87	66·87
Reflective power after two-fold reflection	67·02	63·54	60·77	53·71	49·22	35·91
Reflective power	81·87	79·72	77·96	73·29	70·16	59·93

Sample k

Wave-length	6563	6160	5800	5335	4735	4395
Photometric reading with direct exposure	41·0	53·25	53·1	51·6	45·3	57·2
Aperture of the sector deduced from Fig. 4.	72·81	109·70	109·28	104·84	85·69	123·06
Position on the "Wedge"	4	4	4	4	4	4
Photometric reading of the sample	61·15	62·35	62·0	60·4	50·3	61·6
Aperture of the sector deduced from Fig. 4.	137·36	143·22	140·81	134·31	101·88	139·25
Position on the "Wedge"	7	7	7	7	7	7
Ratio of absorption	66·87	66·87	66·87	66·87	66·87	66·87
Reflective power after two-fold reflection	81·79	71·84	70·98	70·61	65·97	63·07
Reflective power	90·44	84·76	84·25	84·03	81·24	79·42

Sample l

Wave-length	6563	6160	5800	5335	4735	4395
Photometric reading with direct exposure	41·0	53·25	53·1	51·6	45·3	57·2
Aperture of the sector deduced from Fig. 4.	72·91	109·70	109·28	104·84	85·69	123·06
Position on the "Wedge"	4	4	4	4	4	4
Photometric reading of the sample	61·2	62·5	62·0	60·3	50·8	61·6
Aperture of the sector deduced from Fig. 4.	137·39	144·04	140·81	134·10	102·07	139·25
Position on the "Wedge"	7	7	7	7	7	7
Ratio of absorption	66·87	66·87	66·87	66·87	66·87	66·87
Reflective power after two-fold reflection	81·92	72·21	70·98	70·51	66·08	63·07
Reflective power	90·51	84·98	84·25	83·97	81·29	79·42

Table XXII

Reflective Power

Wave-length	6563	6160	5800	5335	4735	4395	4105
Sample d[1]	81·80%	79·66%	77·86%	73·21%	70·05%	59·97%	—
〃 i	81·95%	79·72%	77·73%	73·10%	70·09%	59·97%	—
〃 j	81·87%	79·72%	77·96%	73·29%	70·16%	59·93%	—
〃 k	90·44%	84·76%	84·25%	84·03%	81·24%	79·42%	—
〃 l	90·51%	84·98%	84·25%	83·97%	81·29%	79·42%	—

1 Sample d, which was annealed for 3 hours at 650°, is here cited in comparison with the others.

(2) The System of Copper and Cadmium

For materials, electrolytic copper and Merck's stick cadmium were used, the latter of which had the following purity :—

Table XXIII

Metal	Cd	Pb	Fe	Zn
%	99·20	0·66	0·09	trace

In accordance with Sahmen's state-diagram[1], the following samples were prepared :—

Table XXIV
Composition of the Samples

Samples	a	b	c	d	e	f	g
Percentage of Cadmium	100	99·5	98·89	95·0	90·0	80·0	72·35
Percentage of Copper	0	0·5	1·11	5·0	10·0	20·0	27·65

They were furnace cooled and annealed for one hour at a temperature 50° lower than the eutectic or the melting-temperatures according to the case. A vertical section of each sample in the middle was polished and subjected to determination exactly in the same manner as in the former system. The photogram of the reflected light is given in Fig. 15, and numerical data in Table XXVI and summarized in Table XXV.

Fig. 15.

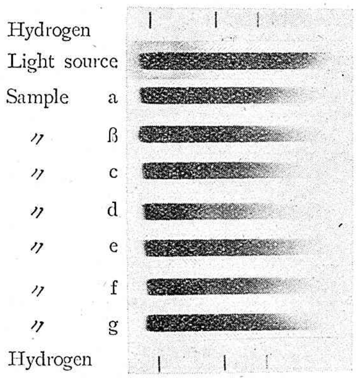


Table XXV
The reflective power of the system of copper and cadmium

Wave-length	6563	6160	5800	5335	4735	4395	4105
Sample a	83·95%	85·92%	84·15%	84·75%	86·18%	85·34%	82·18%
〃 b	80·04%	81·60%	80·24%	79·44%	78·40%	78·05%	77·41%
〃 c	68·73%	69·56%	69·49%	67·05%	66·82%	66·69%	66·37%
〃 d	71·84%	71·99%	73·37%	70·50%	69·39%	69·11%	68·54%
〃 e	72·92%	73·26%	74·21%	72·78%	72·45%	72·18%	71·83%
〃 f	76·25%	77·46%	79·04%	76·19%	73·66%	72·72%	72·11%
〃 g	75·18%	76·27%	78·67%	75·95%	71·88%	67·76%	61·69%

1 Zeit. f. Anorg. Chemie 49 301 (1906).

Table XXVI

Sample a

Wave-length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	52·7	51·0	52·1	51·7	47·3	43·0	54·2
Aperture of the sector deduced from Fig. 4.	108·04	102·40	106·56	105·18	92·17	78·88	112·72
Position on the "Wedge"	4	4	4	4	4	4	4
Photometric reading of the sample	61·4	61·25	61·0	61·4	56·7	51·5	61·3
Aperture of the sector deduced from Fig. 4.	138·11	137·74	136·88	137·26	121·82	104·53	137·45
Position on the "Wedge"	7	7	7	7	7	7	7
Ratio of absorption	66·87	66·87	66·87	66·87	66·87	66·87	66·87
Reflective power after two-fold reflection	70·47	73·81	70·78	71·82	72·64	72·82	67·52
Reflective power	83·95	85·92	84·15	84·75	86·18	85·34	82·18

Sample b

Wave-length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	56·3	55·1	56·2	51·7	46·3	43·0	54·2
Aperture of the sector deduced from Fig. 4.	120·04	115·40	119·56	105·18	92·17	78·88	112·72
Position on the "Wedge"	4	4	4	4	4	4	4
Photometric reading of the sample	61·4	61·4	61·1	56·2	50·3	45·3	56·4
Aperture of the sector deduced from Fig. 4.	138·18	138·60	138·07	119·10	101·38	85·90	120·57
Position on the "Wedge"	7	7	7	7	7	7	7
Ratio of absorption	66·87	66·87	66·87	66·87	66·87	66·87	66 87
Reflective power after two-fold reflection	64·06	66·58	64·38	63·11	61·46	60·91	59·92
Reflective power	80·04	81·60	89·24	79·44	78·40	78·05	77·41

Sample c

Wave-length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	56·3	55·1	56·2	51·7	47·3	43·0	54·2
Aperture of the sector deduced from Fig. 4.	120·04	115·40	119·56	105·18	92·17	78·88	112·72
Position on thd "Wedge"	4	4	4	4	4	4	4
Photometric reading of the sample	49·75	49·3	50·5	44·1	40·4	36·3	45·4
Aperture of the sector deduced from Fig. 4.	98·85	97·60	100·87	82·03	71·36	60·80	85·95
Position on the "Wedge"	7	7	7	7	7	7	7
Ratio of absorption	66·87	66·87	66·87	66·87	66·87	66·87	66·87
Reflective power after two-fold reflection	47·23	48·39	48·28	44·95	44·65	44·47	44·04
Reflective power	68·73	69·56	69·49	67·05	66·82	66·69	66·37

Sample d

Wave-length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	56·3	55·1	56·2	51·7	47·3	43·0	54·2
Aperture of the sector deduced from Fig. 4.	120·04	115·40	119·56	105·18	92·17	78·88	112·72
Position on the "Wedge"	4	4	4	4	4	4	4
Photometric reading of the sample	52·9	51·7	53·6	47·1	42·6	38·2	47·35
Aperture of the sector deduced from Fig. 4.	108·69	105·27	110·82	91·61	77·53	65·74	92·26
Position on the "Wedge"	7	7	7	7	7	7	7
Ratio of absorption	66·87	66·87	66·87	66·87	66·87	66·87	66·87
Reflective power after two-fold reflection	51·60	51·83	53·82	49·70	48·15	47·75	46·97
Reflective power	71·84	71·99	73·37	70·50	69·39	69·11	68·54

Sample e

Wave-length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	53·0	49·8	57·6	51·3	44·1	36·3	55·1
Aperture of the sector deduced from Fig. 4.	109·00	100·41	124·24	103·74	82·11	60·81	115·40
Position on the "Wedge"	4	4	4	4	4	4	4
Photometric reading of the sample	50·9	48·4	56·6	49·2	42·8	34·1	50·9
Aperture of the sector deduced from Fig. 4.	102·24	95·14	121·10	97·19	77·70	55·77	102·31
Position on the "Wedge"	7	7	7	7	7	7	7
Ratio of absorption	66·87	66·87	66·87	66·87	66·87	66·87	66·87
Reflective power after two-fold reflection	53·17	53·66	55·06	53·11	52·49	52·09	51·59
Reflective power	72·92	73·26	74·21	72·78	72·45	72·18	71·83

Sample f

Wave length	6563	6160	5800	5335	4735	4395	4150
Photometric reading with direct exposure	53·0	49·8	57·6	51·3	44·1	36·3	55·1
Apertute of the sector deduced from Fig. 4.	109·00	100·41	124·24	103·74	82·11	60·81	115·40
Position on the "Wedge"	4	4	4	4	4	4	4
Photometric reading of the sample	54·2	52·5	61·6	52·4	42·9	32·1	51·2
Aperture of the sector deduced from Fig. 4.	112·77	107·54	139·13	107·14	78·74	56·70	103·23
Position on the "Wedge"	7	7	7	7	7	7	7
Ratio of absorption	66·87	66·87	66·87	66·87	66·87	66·87	66·87
Reflective power after two-fold reflection	58·13	59·99	62·47	58·04	54·25	52·88	52·00
Reflective power	76·25	77·46	79·04	76·19	73·66	72·72	72·11

Sample g

Wave--length	6563	6160	5890	5335	4735	4395	4105
Photometric reading with direct exposure	53·0	49·8	57·6	51·3	44·1	42·0	55·1
Aperture of the sector deduced from Fig. 4.	109·00	100·41	124·24	103·74	82·11	75·68	115·40
Position on the "Wedge"	4	4	4	4	4	4	4
Photometric reading of the sample	53·1	51·3	61·2	52·1	41·6	36·1	40·6
Aperture of the sector deduced from Fig. 4.	109·34	103·94	137·68	106·41	74·63	60·30	73·21
Position on the "Wedge"	7	7	7	7	7	7	7
Ratio of absorption	66·87	66·87	66·87	66·87	66·87	66·87	66·87
Reflective power after two-fold reflection	56·52	58·16	61·88	57·68	51·67	45·84	38·04
Reflective power	75·18	76·27	78·67	75·95	71·88	67·76	61·69

The relation between the reflective powers and wave lengths as well as that between the reflective powers and the compositions of the

Fig. 16.

System of Cu–Cd

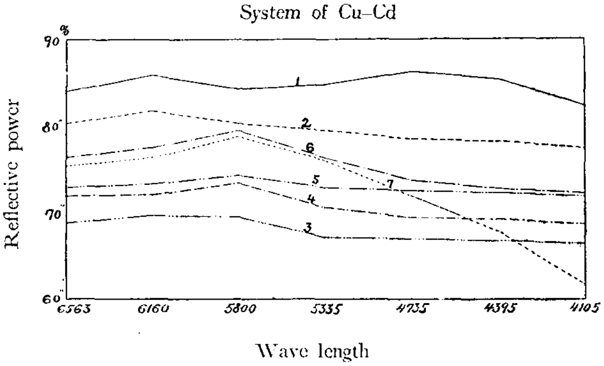
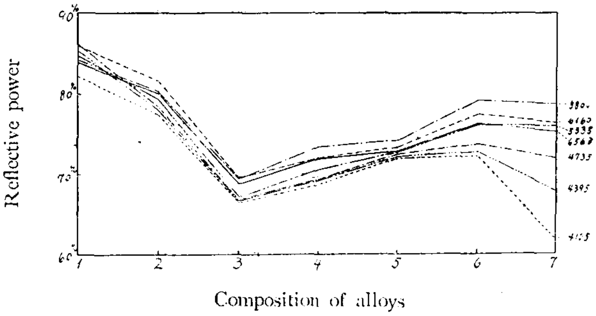


Fig. 17

System of Cu–Cd

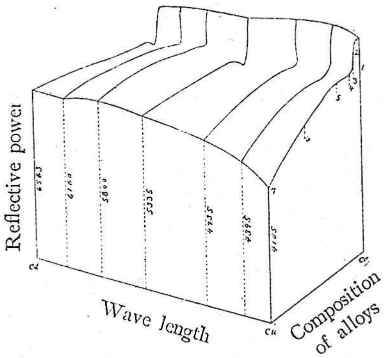


alloys are represented in Figs. 16 and 17 respectively, while the three dimensional relations between reflective powers, wave lengths and compositions of the alloys are represented in Fig. 18.

These Figures point to the minimum points of the reflective powers of all kinds of wave lengths situated in the position of the eutectic.

Fig. 18.

Cu–Cd



(3) The System of Tin and Cadmium.

The cadmium used was the same material as before, while the tin was of the following purity :—

Table XXVII

Metal	Sn	Fe	Pb	As and Sb
%	99·89	0·01	0·03	trace

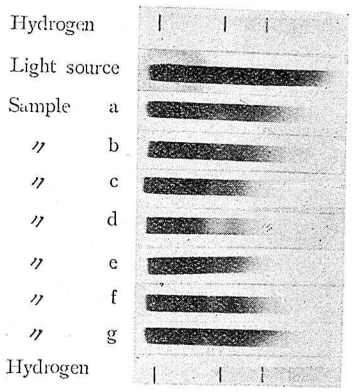
The samples were selected according to Schleicher's state-diagram[1] in the following way :—

Table XXVIII
Composition of the samples

Samples	a	b	c	d	e	f	g
Percentage of tin	0	15	35	68·7	85	93	100
Percentage of Cadmium	100	85	65	31·3	15	7	0

They were completely polished so as to have an optical plane as described in Paragraph 3. The photograms of the reflected light are given in Fig. 19. The numerical data are given in Table XXIX and summarized in Table XXX.

Fig. 19.



1 Intern. Zeits. Metallogr. 2, 76 (1912).

Table XXIX

Sample a

Wave length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	52·7	51·0	52·1	51·7	47·3	43·0	54·2
Aperture of the sector deduced from Fig. 4.	108·04	102·40	106·56	105·18	92·18	78·88	112·72
Position on the "Wedge"	4	4	4	4	4	4	4
Photometric reading of the sample	61·4	61·25	61·0	61·4	56·7	51·5	61·3
Aperture of the sector deduced from Fig. 4.	138·11	137·74	136·88	137·26	121·82	104·53	137·45
Position on the "Wedge"	7	7	7	7	7	7	7
Ratio of absorption	66·87	66·87	66·87	66·87	66·87	66·87	66·87
Reflective power after two-fold reflection	70·47	73·81	70·78	71·82	72·64	72·82	67·52
Reflective power	83·95	85·90	84·15	84·75	86·18	85·34	82·18

Sample b

Wave-length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with derect exposure	42·9	47·7	51·5	51·8	58·7	62·9	60·4
Aperture of the sector deduced from Fig. 4.	78·52	93·20	104·50	105·52	127·98	145·00	134·50
Position on the "Wedge"	2	2	2	2	2	2	2
Photometric reading of the sample	58·8	56·1	56·2	43·5	56·2	62·5	55·3
Apetrure of the sector deduced from Fig. 4.	128·33	119·25	119·54	80·34	119·51	144·35	116·12
Position on the "Wedge"	7	7	7	7	7	7	7
Ratio of absorption	43·86	43·86	43·86	43·86	43·86	43·86	43·86
Reflective power after two-fold reflection	59·98	44·74	43·38	29·95	32·49	38·23	33·59
Reflective power	77·45	66·89	65·86	63·21	57·00	61·83	57·96

Sample c

Wave length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	56·2	51·8	48·5	48·7	49·6	51·4	51·5
Aperture of the sector deduced from Fig. 4.	119·56	105·52	95·28	95·59	98·45	104·12	104·50
Position on the "Wedge"	2	III	III	III	III	III	III
Photometric reading of the sample	32·1	58·1	44·7	49·0	45·9	49·0	47·3
Aperture of the sector deduced from Fig. 4.	50·89	125·82	83·81	96·85	86·68	96·68	92·10
Position on the "Wedge"	7	VII	VII	VII	VII	VII	VII
Ratio of absorption	43·86	14·75	14·75	14·75	14·75	14·75	14·75
Reflective power after two-fold reflection	17·64	16·71	13·36	14·40	10·40	11·75	10·34
Reflective power	42·00	40·87	35·16	37·97	31·74	34·28	32·16

Sample d

Wave length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	50·2	62·3	51·8	59·7	60·1	56·6	61·6
Aperture of the sector deduced from Fig. 4.	100·12	142·88	105·52	131·88	133·30	121·30	139·14
Position on the "Wedge"	III	III	III	III	III	III	III
Photometric reading of the sample	47·5	58·6	38·5	38·7	30·6	37·9	35·4
Aperture of the sector deduced from Fig. 4.	92·72	127·73	66·33	66·89	46·34	65·01	58·65
Position on the "Wedge"	VII	VII	VII	VII	VII	VII	VII
Ratio of absorption	14·75	14·75	14·75	14·75	14·75	14·75	14·75
Reflective power after two-fold reflection	12·07	12·86	75·87	62·40	44·25	65·63	52·76
Reflective power	34·87	35·86	27·52	24·98	21·04	25·62	22·97

Sample e

Wave length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	51·1	62·1	55·6	62·2	61·7	51·4	51·5
Aperture of the sector deduced from Fig. 4.	102·98	141·56	117·82	142·22	139·54	104·12	104·50
Position on the "Wedge"	2	2	III	2	2	III	III
Photometric reading of the sample	29·6	45·0	54·2	26·3	29·3	47·7	46·8
Aperture of the sector deduced from Fig. 4.	42·72	84·78	112·75	41·50	41·16	93·13	90·86
Position on the "Wedge"	7	7	VII	7	7	VII	VII
Ratio of absorption	43·86	43·86	14·75	43·86	43·86	13·75	14·75
Reflective power after two-fold reflection	17·23	24·07	13·96	11·68	10·15	11·06	96·28
Reflective power	41·52	49·07	37·77	34·18	31·87	33·26	31·03

Sample f

Wave length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	51·5	62·1	55·6	62·2	61·7	51·4	51·5
Aperture of the sector deduced from Fig. 4.	102·98	141·56	117·82	142·22	139·54	104·12	104·50
Position on the "Wedge"	2	2	2	2	2	III	III
Photometric reading of the sample	44·9	63·0	42·6	30·1	29·6	49·7	48·9
Aperture of the sector deduced from Fig. 4.	84·29	145·35	77·41	44·50	42·89	99·49	96·42
Position on the "Wedge"	7	7	7	7	7	VII	VII
Ratio of absorption	43·86	43·86	43·86	43·86	43·36	14·75	14·75
Reflective power after two-fold reflection	31·99	39·00	26·20	23·43	11·31	13·66	11·79
Reflective power	56·57	62·69	51·19	35·26	33·63	36·97	34·35

Sample g

Wave length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	51·0	42·6	55·0	57·4	57·0	61·6	60·4
Aperture of the sector deduced from Fig. 4.	192·98	77·45	115·00	123·62	122·50	139·14	134·50
Position on the "Wedge"	III	2	III	II	2	2	2
Photometric reading of the sample	29.6	59·0	37·5	33·3	50·8	61·4	56·9
Aperture of the sector deduced from Fig. 4.	43·92	128·84	63·81	53·95	102·35	138·52	122·32
Position on the "Wedge"	VII	7	VII	VII	7	7	7
Ratio of absorption	14·75	43·86	14·75	12·18	43·86	43·86	43·86
Reflective power after two-fold reflection	53·49	61·00	50·28	45·59	32·60	38·23	35·21
Reflective power	73·14	78·10	70·91	67·52	57·10	61·81	59·34

Table XXX

The Reflective Power of the System of Cadmium and Tin.

Wave length		6563	6160	5800	5335	4735	4395	4105
Sample	a	83·95%	85·90%	84·15%	84·75%	86·18%	85·34%	82·18%
〃	b	77·45%	66·89%	65·86%	63·21%	57·00%	61·83%	57·96%
〃	c	42·00%	40·87%	35·16%	37·97%	31·74%	34·28%	32·16%
〃	d	34·87%	35·86%	27·52%	24·98%	21·04%	25·62%	22·97%
〃	e	41·52%	49·07%	37·77%	34·18%	31·87%	33·26%	31·03%
〃	f	56·57%	62·69%	51·19%	35·26%	33·63%	36·97%	34·35%
〃	g	73·14%	78·10%	70·91%	67·52%	57·10%	61·81%	59·34%

The relation between the reflective powers and wave lengths as well as that between the reflective powers and the compositions of the

Fig. 20.

System of Cd–Sn

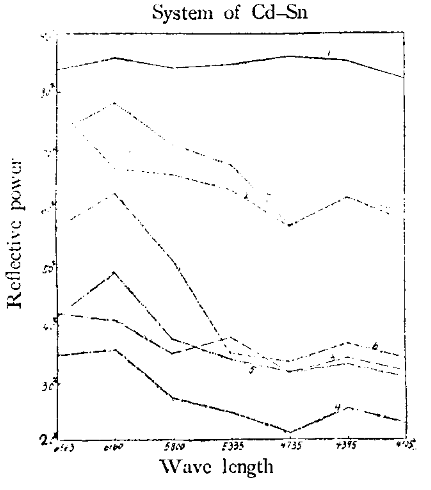
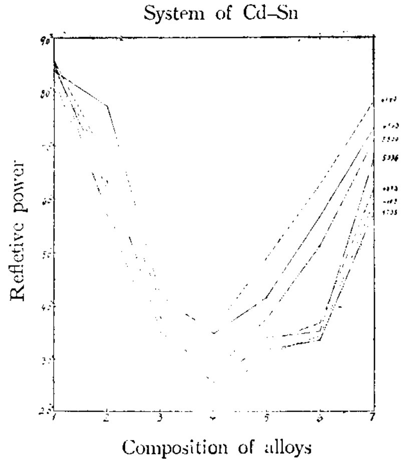


Fig. 21.

System of Cd–Sn

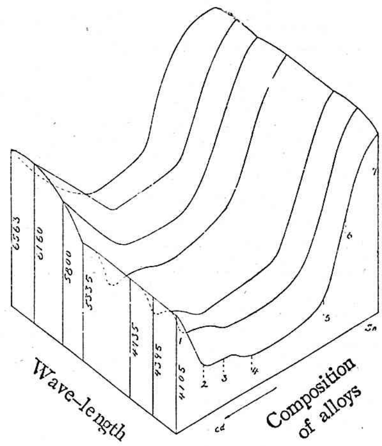


alloys are as represented in Figs. 20 and 21 respectively, while the three dimensional relations between reflective powers, wave lengths and compositions of the alloys are as represented in Fig. 22.

The minimum point of the reflected powers for any wave length is here also found to be in the position of the eutectic.

Fig. 22.

System of Cd–Sn



(4) The System of Bismuth and Cadmium.

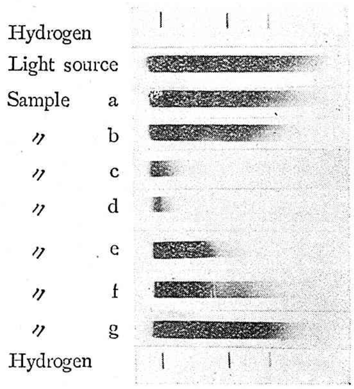
The cadmium used was the same as before, and the bismuth of the purity of 99.25%, the remainder being 0·20% Ag and 0·61% Mn. The samples were selected, according to Petrenko and Fedorow's state-diagram[1], as in Table XXXI and polished to an optical plane. In order to avoid oxidation, the samples were polished with rouge on a pitch plate wetted with absolute alcohol, washed with ether and quickly dried.

Table XXXI
The Composition of the Samples

No. of Samples	a	b	c	d	e	f	g
Percentage of Cadmium	100	81	62	40	26	13	0
Percentage of Bismuth	0	19	38	60	74	87	100

The photograms of the spectra are given in Fig. 23 and the results of determination are given in Table XXXII and summarized in Table XXXIII.

Fig. 23.



1 Intern. Zeits. Metallogr. **6**, 212 (1914).

Table XXXII

Sample a

Wave length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	52·7	51·0	52·1	51·7	47·3	43·0	54·2
Aperture of the sector deduced from Fig. 4.	108·04	102·40	106·56	105·18	92·18	78·88	112·72
Position on the "Wedge"	4	4	4	4	4	4	4
Photometric reading of the sample	61·4	61·25	61·0	61·4	56·7	51·5	61·3
Aperture of the sector deduced from Fig. 4.	138·11	137·74	136·88	137·26	121·82	104·53	137·45
Position on the "Wedge"	7	7	7	7	7	7	7
Ratio of absorption	66·87	66·87	66·87	66·87	66·87	66·87	66·87
Reflective power after two-fold reflection	70·47	73·81	70·78	71·82	72·64	72·82	67·52
Reflective power	83·95	85·90	84·15	84·75	86·18	85·34	82·18

Sample b

Wave length	6563	6160	5800	5335	4735	4395	4105
Photometric reading withdirect exposure	49·1	55·6	49·0	49·0	45·0	46·7	45·4
Aperture of the sector deduced from Fig. 4.	97·10	51·88	96·83	96·83	84·72	90·41	85·93
Position on the "Wedge"	2	2	2	2	2	2	2
Photometric reading of the sample	52·3	31·2	40·8	50·5	58·3	61·3	61·1
Aperture of the sector deduced from Fig. 4.	107·12	48·40	72·52	101·05	126·61	137·54	137·12
Position on the "Wedge"	7	7	7	7	7	7	7
Ratio of absorption	43·86	43·86	43·86	43·86	43·86	43·86	43·86
Reflective power after two-fold reflection	41·99	36·03	25·51	39·91	55·33	69·33	58·75
Reflective power	64·79	60·03	54·33	69·43	74·39	79·95	76·65

Sample c

Wave length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	62·3	60·1	61·0	56·5	58·6	61·4	58·4
Aperture of the sector deduced from Fig. 4.	142·88	133·30	136·80	121·04	127·60	138·32	126·96
Position on the "Wedge"	III	II	2	2	II	III	II
Photometric reading of the sample	57·7	49·5	44·6	54·0	34·5	35·5	31·3
Aperture of the sector deduced from Fig. 4.	124·75	99·24	83·37	111·94	56·85	77·00	49·00
Position on the "Wedge"	VII	VII	7	7	VII	VII	VII
Ratio of absorption	14·75	12·18	43·86	43·86	12·18	14·75	12·18
Reflective power after two-fold reflection	99·22	74·09	30·17	32·25	46·44	53·20	40·76
Reflective power	31·50	27·22	17·37	17·96	21·55	23·07	20·19

Sample d

Wave length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	62·3	60·1	55·6	58·4	59·0	61·4	58·0
Aperture of the sector deduced from Fig. 4.	142·88	133·30	117·32	126·96	128·85	138·32	125·60
Position on the "Wedge"	III	II	2	2	2	III	2
Photometric reading of the sample	57·0	61·5	33·3	35·7	53·2	45·1	50·0
Aperture of the sector deduced from Fig. 4.	122·60	138·95	54·20	59·21	109·41	85·08	99·59
Position on the "Wedge"	VII	VII	7	7	7	VII	7
Ratio of absorption	14·75	12·18	43·86	43·86	43·86	14·75	43·86
Reflective power after two-fold reflection	84·73	48·22	19·01	19·20	33·08	46·85	31·08
Reflective power	29·11	21·96	13·79	13·86	18·19	21·40	17·63

Sample e

Wave length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	62·3	62·5	61·6	57·0	58·6	61·4	58·4
Aperture of the sector deduced from Fig. 4.	142·88	144·20	139·14	122·50	127·60	138·32	126·96
Position on the "Wedge"	III	III	II	II	II	III	II
Photometric reading of the sample	59·6	57·8	32·2	30·2	41·2	39·2	33·8
Aperture of the sector deduced from Fig. 4.	162·26	124·90	51·17	45·21	73·43	68·37	55·27
Position on the "Wedge"	VII	VII	VII	VII	VII	VII	VII
Ratio of absorption	14·75	14·75	12·18	12·18	12·18	14·75	12·8
Reflective power after two-fold reflection	11·74	93·33	39·08	39·12	58·61	60·66	45·45
Reflective power	34·27	30·55	19·77	19·78	24·21	24·96	21·32

Sample f

Wave length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	62·3	62·5	61·6	57·0	62·1	61·4	60·5
Aperture of the sector deduced from Fig. 4.	142·88	144·20	139·14	122·50	141·58	138·32	134·90
Position on the "Wedge"	III	III	II	II	III	III	III
Photometric reading of the sample	32·8	57·6	38·1	36·7	59·2	57·6	55·4
Aperture of the sector deduced from Fig. 4.	52·83	124·40	65·31	61·75	129·70	124·34	11·62
Position on the "Wedge"	VII	VII	VII	VII	VII	VII	VII
Ratio of absorption	14·75	14·75	12·18	12·18	14·75	14·75	14·75
Reflective power after two-fold reflection	12·25	97·71	48·70	51·98	11·41	10·69	91·62
Reflective power	35·00	31·26	22·07	22·80	33·78	34·86	30·27

Sample g.

Wave length	6963	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	60·6	58·6	62·2	39·8	52·1	55·8	55·7
Aperture of the sector deduced from Fig. 4.	135·28	127·60	142·22	69·95	106·44	117·96	117·64
Position on the "Wedge"	2	2	2	2	2	2	2
Photometric reading of the sample	59·1	47·0	35·2	30·5	32·5	53·2	46·4
Aperture of the sector deduced from Fig. 4.	129·53	91·33	59·33	46·08	51·89	109·64	89·52
Position on the "Wedge"	7	7	7	7	7	7	7
Ratio of absorption	43·86	43·86	43·86	43·86	43·86	43·86	43·86
Reflective power after two-fold reflection	36·89	28·31	17·07	26·26	19·96	35·88	29·94
Reflective power	60·75	52·31	53·48	51·25	44·68	59·91	54·72

Table XXXIII

The reflective power of the system of bismuth and cadmium

Wave length		6563	6160	5800	5335	4735	4395	4105
Sample	a	83·95%	85·90%	84·15%	84·75%	86·18%	85·34%	82·18%
〃	b	64·95%	60·03%	54·33%	69·43%	74·39%	79·95%	76·65%
〃	c	31·50%	27·22%	17·37%	17·96%	21·55%	23·07%	20·19%
〃	d	29·11%	21·96%	13·79%	13·86%	18·19%	21·40%	17·63%
〃	e	34·27%	30·55%	19·77%	19·78%	24·21%	24·69%	21·32%
〃	f	35·00%	31·26%	22·07%	22·80%	33·73%	34·86%	30·27%
〃	g	60·75%	52·31%	53·48%	51·25%	44·68%	55·91%	54·72%

Fig. 24.
Bi-Cd

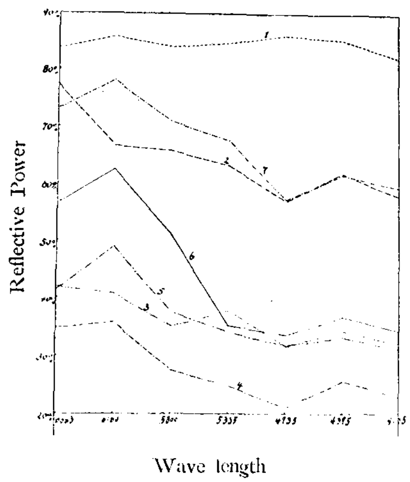
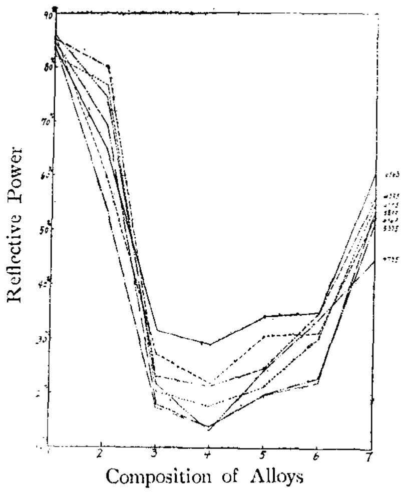
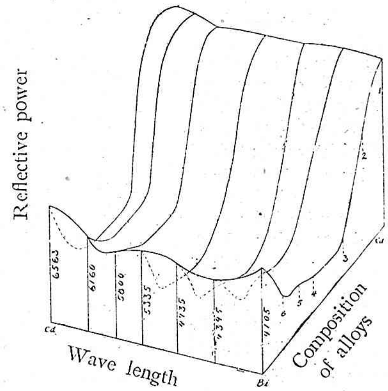


Fig. 25.
Bi-Cd



The relation between the reflective powers and the wave lengths, as well as that between the reflective powers and the compositions are as represented in Figs. 24 and 25 respectively, while the three dimensional relations between the reflective powers, wave lengths and compositions are represented in Fig. 26. The minimum points of reflected powers for all kinds of wave lengths are also found to be at the eutectic point.

Fig. 26.



(5) The System of Bismuth and Tin.

The samples were selected according to Guertler's state-diagram[1] and polished to an optical plane. They had the following composition :—

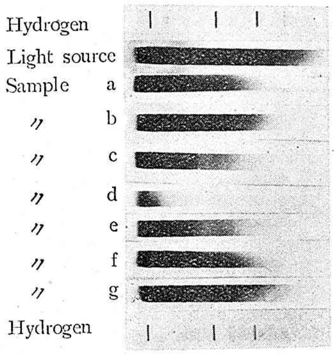
Table XXXIV

Composition of the sample

No. of Samples	a	b	c	d	e	f	g
Percentage of Tin	0	13	27	42	62	81	100
Percentage of Bismuth	100	87	73	58	38	19	0

The photograms of the reflected light are given in Fig. 27, and the numerical data in Table XXXV and summarized in Table XXXVI.

Fig. 27.



The relation between the reflective powers and the wave lengths, as well as that between the reflective powers and the compositions are represented in Figs. 28 and 29 respectively, while the three dimensional relations between the reflective powers, wave-lengths and compositions are represented in Fig. 30. The minimum points of the reflected powersfor all kinds of wave lengths are here also found at the eutectic point.

1 Guertler, Metallographie I, 738 (1912).

Table XXXV

Sample a

Wave length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	60·6	28·6	62·2	39·8	52·1	55·8	55·7
Aperture of the sector debuced from Fig. 4.	135·28	127·60	142·22	69·95	106·44	117·96	117·64
Position on the "Wedge"	2	2	2	2	2	2	2
Photometricr eading of the sample	59·1	47·0	35·2	30·5	32·5	53·2	46·4
Aperture of the sector deduced frgm Fig. 4.	129·53	91·33	59·33	46·08	51·89	109·64	89·52
Position on the "Wedge"	7	7	7	7	7	7	7
Ratio of absorption	43·86	43·86	43·86	43·86	43·86	43·86	43·86
Reflective power after two-fold reflection	36·89	28·31	17·07	26·26	19·96	35·88	29·94
Reflective power	60·75	52·31	53·48	51·25	44·68	59·91	54·72

Sample b

Wave length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	58·6	51·1	44·0	46·9	46·3	37·2	52·5
Aperture of the sector deduced from Fig. 4.	127·60	102·98	81·85	91·08	89·09	62·98	107·4
Position on the "Wedge"	III	III	III	III	III	III	2
Photometric reading of the sample	61·8	58·6	55·2	48·7	57·1	53·5	33·4
Aperture of the sector deduced from Fig. 4.	139·84	127·62	115·76	95·92	122·73	111·92	54·18
Position on the "Wedge"	VII	VII	VII	VII	VII	VII	7
Ratio of absorption	14·75	14·75	14·75	14·75	14·75	14·75	43·86
Reflective power after two-fold reflection	15·48	17·30	19·52	14·93	19·03	24·02	20·06
Reflective Power	39·35	41·60	44·19	38·64	43·63	49·02	44·79

Sample c

Wave length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	58·6	58·0	61·7	46·9	46·3	37·2	53·4
Aperture of the sector deduced frhm Fig. 4.	127·60	125·60	139·28	156·02	89·09	62·98	110·12
Position oo the "Wedge"	III	III	III	III	III	III	III
Photometric reading of the sample	60·6	59·4	61·2	43·0	52·0	50·5	62·1
Aperture of the sector deduced from Fig. 4.	135·43	130·69	137·74	78·74	106·3	101·01	141·75
Position on the "Wedge"	VII	VII	VII	VII	VII	VII	VII
Ratio of absorption	14·75	14·75	14·75	14·75	14·75	14·75	12·18
Reflective power after two-fold refleetion	15·03	14·79	14·08	11·68	16·72	21·88	17·91
Reflective power	38·77	38·46	37·53	34·18	40·89	46·78	42·32

Sample d

Wave length	6563	6160	5800	5335	4735	4395	4105
Photomerite reading with direct exposure	62·4	54·3	53·1	60·0	62·5	56·6	61·7
Aperture of the sector deduced from Fig. 4.	143·54	112·98	109·28	132·90	144·20	121·30	139·28
Position on the "Wedge"	III	III	III	III	III	III	III
Photometric reading of the sample	58·1	49·8	34·6	43·9	59·4	58·8	57·0
Aperture of the sector deduced from Fig. 4.	125·91	98·42	56·98	81·53	130·82	188·22	122·45
Position on the "Wedge"	VII	VII	VII	VII	VII	VII	VII
Ratio of absorption	14·75	14·75	14·75	14·75	14·75	14·75	14·75
Reflective power after two-fold reflection	10·28	97·78	63·99	74·21	11·00	13·84	10·03
Reflective power	32·09	31·27	25·30	27·24	33·18	37·21	31·68

Sample e

Wave length	6563	6160	5800	5335	4735	4955	4105
Photometric reading with direct exposure	62·4	57·3	56·5	53·1	62·0	57·9	61·7
Aperture of the sector deduced from Fig. 4.	143·54	123·34	121·00	109·28	140·70	125·26	139·28
Position on the "Wedge"	2	III	III	III	III	III	III
Photometii reading of the sample	38·2	54·9	30·5	51·4	59·3	60·2	58·3
Aperture of the sector deduced from Fig. 4.	65·19	114·61	46·12	104·04	130·44	132·12	125·51
Position on the "Wedge"	7	VII	VII	VII	VII	VII	VII
Ratio of absorption	43·86	14·75	14·75	14·75	14·75	14·75	14·75
Reflective power after two-fold reflection	18·72	12·29	72·25	84·10	12·04	14·95	10·86
Reflective power	43·27	35·07	26·88	29·00	34·70	38·67	32·96

Sample f

Wave length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	60·6	58·6	62·2	56·6	56·6	55·8	55·7
Aperture of the sector deduced from Fig. 4.	135·28	127'60	142·22	121·30	121·30	117·96	117·64
Position on the "Wedge"	2	2	2	2	2	2	2
Photometric reading of the sample	48·6	37·0	3·25	35·3	39·3	50·9	45·9
Apertnre of the sector deduced from Fig. 4.	95·70	62·52	58·33	60·95	68·36	103·24	87·62
Position on the "Wedge"	7	7	7	7	7	7	7
Ratio of absorption	43·86	43·86	43·86	43·86	43·86	43'86	43·86
Reflective power after two-fold reflection	28·01	20·05	17·07	23·26	25·67	33·98	29·45
Reflective power	52·92	44·79	41·32	48·23	50·67	58·30	54·27

Sample g.

Wave length	6563	6160	5800	5335	4735	4395	4105
Photometric reading with direct exposure	51·0	42·6	55·0	57·4	57·0	61·6	60·4
Aperture of the sector deduced from Fig, 4.	102·98	77·45	115·00	123'62	112·62	139·14	134·50
Position on the "Wedge"	III	2	III	II	2	2	2
Photometric reading of the sample	29·6	59·0	37·5	33·3	50·8	61·4	56·9
Apeiture of the sector deducee from Fig· 4.	43·92	128·84	63·81	53·95	102·35	138·52	122·32
Position on the "Wedge"	VII	7	VII	VII	7	7	7
Ratio of absorption	14·75	43·86	14 75	12·18	43·86	43·86	43·86
Reflective power after two-fold reflectian	53·49	61·00	20·28	45·59	32·60	38·23	35·21
Reflection power	73·14	78·10	70·91	67·52	57·10	61·81	59·34

Table XXXVI.

The reflective power of the alloys of the System :—

Wave length		6563	6160	5800	5335	4735	4395	4105
Sample	a	60·75%	52·31%	53·48%	51·25%	44·68%	59·91%	54·72%
〃	b	39·35%	41·60%	44·19%	38·64%	43·63%	49·02%	44·79%
〃	c	38·77%	38·46%	37·53%	34·18%	40·89%	46·78%	42·32%
〃	d	32·09%	31·27%	25·30%	27·24%	33·18%	37·21%	31·68%
〃	e	43·27%	35·07%	26·88%	29·00%	34·70%	38·67%	32·96%
〃	f	52·92%	44·79%	41·32%	48·23%	56·67%	58·30%	54·27%
〃	g	73·14%	78·10%	70·91%	67·52%	57 10%	61·81%	59·34%

Fig. 28.
Bi–Sn

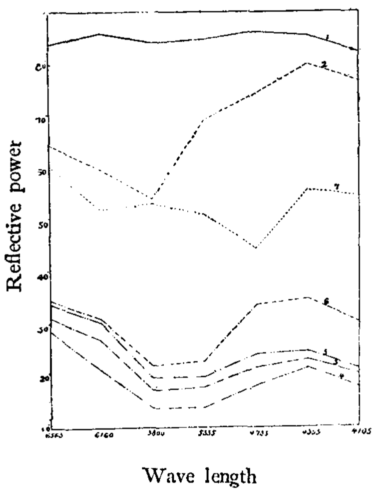


Fig. 29.
Bi-Sn

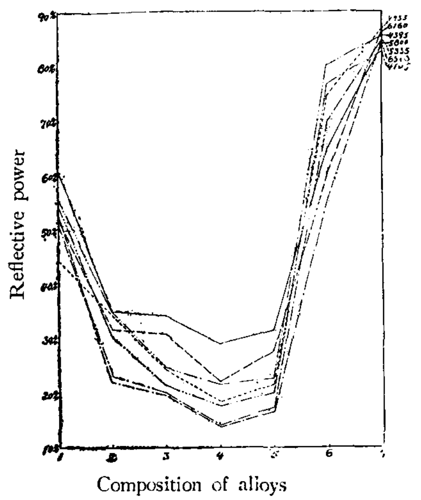


Fig. 30.

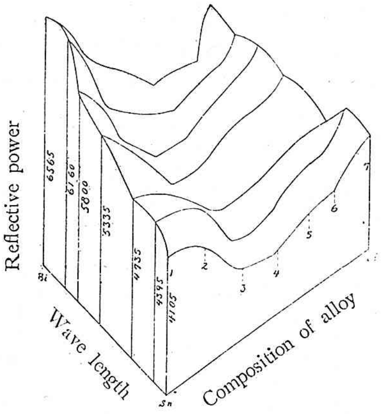
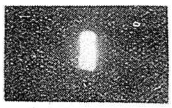
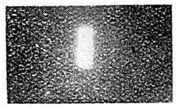


Fig. 31.



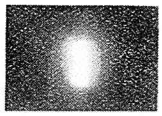
Pure tin

Fig. 32.



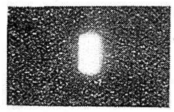
Alloy of
93% *Sn* and 7% *Cd*

Fig. 33.



Alloy of
85% *Sn* and 15% *Cd*

Fig. 34.



Eutectic alloy of
68·7% *Sn* and 31·3% *Cd*

VI Discussion of the Results.

The experiments have shown that the reflective power of the binary eutectic alloys has usually a minimum at the eutectic point, excepting the case where the reflective powers between 2 components are considerably different. In the latter case, as other workers have already shown[1], the minimum is liable to deviate to the side of the weaker component. As for the reason why the eutectic shows the minimum, one might consider that, the eutectic, being harder than any other alloy of the same components, is apt to get the more rough polish, in consequence of which the reflection is worse. This consideration is however not right. Our experiments with the alloys, *Bi–Sn*, *Sn–Cd* and *Cd–Bi*, which were each polished to an optical plane, showed actually not much difference in their reflective power in comparison with the alloys not optically plane. In fact, the optical plane of *Sn–Cd* had a reflective power only 3% higher, that of *Cd–Bi* 2·8%, and that of *Bi–Sn* 3·5%. These results indicate that the roughness of surface is not the real cause of the minimum reflection.

Another consideration is as follows :— the thickness of the lamella in the eutectie must, of course, be different in different alloys, but it may be probably assumed that it has in the average the order of Belaiew's determination[2]. The incident ray upon the surface of the eutectic must

1 Zeit. f, Anorg. Chemie **194**, 334 (1926).

2 Belaiew, Inst. Iron and Steel, 1922, 201, points out that the thickness of the cementite lamella in pearlite is in order of 75 μμ.

have, while transmitting some lamella, some part absorbed or scattered owing to the irregularity of the centre of diffraction. This absorption or scattering, due to the fine structure of the eutectic, might therefore be the principal cause of the low reflective power. As to the scattering effect, we present some photograms showing the image of the slit, through which pass the reflected rays from *Cd–Sn* alloys, in Figs. 31, 32, 33 and 34. The image of the eutectic gives there the largest opening owing to the strongest scattering effect.

The present study has been carried out under the kind suggestions and encouragement of Professor M. Chikashige to whom are due the investigator's cordial thanks.