electron has the mass 1.007, very nearly. This might be stated more accurately by giving the weight of the average electron pair, positive plus negative electron, as 1.000 ± 0.001 in any complex atom, but as 1.0077 in hydrogen itself where the positive electron is *free* and not bound. The constancy in the packing effect may be a characteristic of the positive and negative electrons themselves.

20. In considering the foregoing paper it should be realized that it develops some *very general relations*, such as those involving the ratio of negative to positive electrons in the nucleus (N/P), which are very likely to prove entirely valid, and that it gives very *special details*. such as formulas for nuclei, etc., which are not expected to fit the facts in every special case, but are only intended to illustrate the general relations and to give a specific theory to which the facts as they are discovered may be related. The nucleus is so complex that it is possible that nuclei of atoms of the same element may have a different composition with reference to the particles of masses 4, 3, 2, and 1, even when their atomic weights are the same. It is quite likely that the relations concerning the ratio N/P are much more general than those relating to the specific formulas. Thus the important feature about the oxygen nucleus *may* be that in it the ratio N/P is 0.5, and not so much that it consists of 4 α- particles.

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THE X-RAY FLUORESCENCE OF CERTAIN ORGANIC COMPOUNDS.

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Received April 26, 1920.

In a previous[1] paper I pointed out that it might in the future become possible to make use, biologically, of a localized transformation of penetrative radiant energy with very feeble abiotic properties (X-ray), into a much more active, although less penetrative type of ray (ultra-violet) through fluorescent substances as intermediaries. It was shown, in fact, that fluorite under the influence of the X-ray emitted bactericidal rays. Progress from this point demanding that we have for use in place of the insoluble fluorite a similarly active soluble substance, a survey was made of a large number of substances, for the most part organic chemicals, to see which of them might fluoresce under the influence of the X-ray.

Kunz and Baskerville[2] have examined the action of radiation on 13,000 minerals in the collection of the American Museum of Natural History. Their most noteworthy observations were the variability in like minerals

[1] H. S. Newcomer, *J. Exp. Med.*, **26**, 675 (1917).

[2] G. F. Kunz and Chas. Baskerville, *Science*, **18**, 769 (1903).

from the same source. There would seem to be 2 types of fluorescence, a specific type characteristic of the substance such as is found in the case of fluorite and a nonspecific type variably associated with the substance as in the case of willemite, hyalite, gypsum, etc. Others publishing literature on X-ray fluorescence are Edison,[1] Burbank,[2] Arnold,[3] and Precht,[4] Wiedemann and Schmidt.[5]

Pohl[6] has determined the amount of energy transformed into fluorescent light by barium platinocyanide and by calcium wolframite and finds it to be 3.7%. McIlkney[7] states that calcium tungstate crystals emit light whose wave length is further toward the ultra-violet the smaller are the crystals. The range is given as from the yellow to the ultra-violet border.

Our examination included both visual and photographic observations. The purpose of the latter was to detect any invisible ultra-violet radiation which might be developed, the ordinary photographic plate being uniformly sensitive from about 5000 Ångstrom units (blue-green), down to 2200 Ångstrom units, quite far out into the ultra-violet. The X-rays fell horizontally on the compounds arranged 6 at a time in separate black pasteboard compartments directly beneath a Graflex plate; the plate being protected from the action of the X-rays by a $^1/_2$-inch block of lead in its plane. The exposures were for 2 minutes. The solid compounds were placed in black paper containers, the liquids in 30 cc. "Nonsol" beakers, the photographic effect of whose fluorescence was practically nil.

In order to determine the presence of visible fluorescence the eyes were first thoroughly dark-accommodated and kept so, assistants doing all the handling of the materials. The solids were placed on black sheets of paper, the liquids in paraffined paper cups, the fluorescence of which was barely within the limits of visibility.

The X-ray tube was entirely enclosed. The rays passed through, besides the glass of the tube itself, a layer of black paper. All of the compounds were also examined with the additional interposition of a one mm. aluminum screen. The effect of the screen was to reduce slightly the intensity of the fluorescence observed.

The machine was a Victor fluoroscopic outfit of 1500 watts capacity, having a Coolidge fine focus tube. The distance of the compound from the anticathode was 22 cm. The machine was run at about a maximum

[1] Thos. Edison, *Elec. Rev.*, **165**, 53 (1896).
[2] J. J. Burbank, *Amer. J. Sci.*, **155**, 53 (1898).
[3] W. Arnold, *Ann. physik. Chem.* n. f., **61**, 313 (1897).
[4] J. Precht, *ibid.*, **61**, 330 (1897).
[5] E. Wiedemann and G. C. Schmidt, *ibid.*, **56**, 201 (1895).
[6] R. Pohl, "Die Physik der Röntgenstrahlen," Braunschweig, **1912**, 147.
[7] P. C. McIlkney, *Elec. World*, **28**, 664 (1896).

continuous load, the energy delivered varying slightly from time to time, but being maintained so as to give a maximum illumination of the fluorescing screen of the outfit, the existence of such a maximum being frequently checked. As the machine did not have good meters the exact conditions were not known, but the current across the tube was about 15 milliamperes and the potential about 55,000 volts, these figures being checked by later measurements in which the conditions of the experiment were reproduced.

There is good reason for believing that maximum fluorescence is produced by a maximum delivery of X-ray energy, or that within a considerable range the fluorescence is independent of the quality of the X-rays and proportional to the energy alone. Several experiments were set up, using a much larger machine and a new Coolidge tube in which a fluorescent screen, indeed several screens, were radiated without the interposition of anything between the screen surface and the X-ray tube except black paper, selective absorption of the softer rays, especially by aluminum, being avoided. Using various potentials across the tube the current was so adjusted as to produce a certain definite faint fluorescence in the screen, the intensity of the fluorescence being taken such as to make variations most perceptible. The current was read on a milliammeter and the voltage computed from the alternative spark gap between 1.9 mm. polished steel balls.[1,2] It was found that with the intensity of the fluorescence judged constant the product of the milliamperage and the square of the potential was approximately constant, that is, the energy was constant. The potential range was from about 10,000 to 70,000 volts. Within some such range the fluorescence is thus independent of the X-ray wave length and dependent on the energy alone. So far as I can determine the quality of the fluorescence, its color, is dependent on the substance alone and not on the quality of the X-rays.

The compounds used were not specially purified. The larger number of the organic compounds were imported commercial samples. Some were prepared in the laboratory in the course of the synthesis of dyes. The dyes were mostly of German origin.

It is well known that slight impurities may determine the character of fluorescence. Fluorescence is, however, not necessarily associated with the presence of impurities. Of the compounds listed in Table II only the fluorescence of the amino acids seems to have been due to the presence of impurities. In general, compounds of different origin and occasionally even of different appearance behaved alike under the X-rays. Occasionally small particles of presumably foreign material were observed as brightly shining specks in an inert material.

[1] F. E. Fowle, *Smithsonian Inst. Pub.*, **63**, 2269 (1918), No. 6.

[2] G. W. C. Kaye and T. H. Laby, "Tables of Physical and Chemical Constants and some Mathematical Functions," London, **1916**.

In recording the visual effect produced by the fluorescence it was convenient to take 1+ as the minimum of light that could be seen with certainty and 8+, corresponding to the luminosity of the several diamonds which were tried, as the maximum luminosity observed. It was found possible to recognize differences repeatedly in this scale. It was, of course, necessary to consider only the surface brightness of the substance and not the total quantity of light which a large body might emit. The recording of visual intensity is somewhat unsatisfactory because its apparent amount is so closely connected with its color. The dark-accommodated eye is most sensitive to light of wave length about 5400 Ångstrom units (green). Its sensitivity varies much with the color and in its region of maximum sensitivity it can detect light many times fainter than that in any region necessary to affect the photographic plate.

All of the compounds which affected the photographic plate were studied spectrographically. They were placed in paste-board containers before a 3 mm. slit of a quartz spectrograph (size C, Adam Hilger), and X-rayed for 2 hours. Eastman Graflex plates were used. Allowing for the distortion due to the wide slit, Table I gives the wave lengths and general characteristics of the fluorescent light so analyzed.

The result of the survey is to show that many organic compounds, whether solid or liquid, fluoresce under the X-ray. This fluorescence lies more commonly in the violet, blue and green parts of the spectrum. It is rarely sufficiently strong to affect a photographic plate. It is often at the violet-ultra-violet border. It seems probable that in approaching the far ultra-violet fluorescence becomes less common. A set up to determine the existence of a fluorescence of wave length appreciably less than 2000 Ångstrom units would be extraordinarily difficult and tedious to execute. Fluorescence is again common in the region of the X-ray spectrum.

As a rule liquids, amorphous colored substances (dyes) and substances in solution, when they are fluorescent, are feebly so and the conditions as to the observation must be rigid, particularly in respect to darkness and accommodation. Solutions in water of fluorescing solids have in some instances been tried. These solutions have been faintly fluorescent. The faintness is in part accounted for by the dilution of the material. It does not seem to be proportional to the dilution, but no extended study has been made of this question. Amorphous colored compounds seem to be distinctly less fluorescent than closely related but distinctly crystalline substances. There are, however, many colorless amorphous substances which fluoresce brightly. Most of them are inorganic compounds, in fact the most brightly fluorescing compounds are inorganic Many of those substances which give off bright and often distinctly colored light when subjected to ultra-violet radiation give off light just as strongly under the influence of X-rays. The ordinary luminous watch is a good

example. It is interesting that the air is very faintly fluorescent under the action of X-rays. Certain compounds were found to be distinctly phosphorescent.

The results of this work when assembled are apparently not susceptible of rational classification based on chemical relationships. They are, therefore, arranged in two tables, II and III, giving the visible fluorescence observed.

Sodium bromide is the only substance found which emits rays of wave lengths which we know to be bactericidally active (below 2800 Ångstrom units). Of organic compounds certain phenols and other benzene derivatives approach this most closely. Visible fluorescence of considerable intensity without effect on the photographic plate was found quite commonly among derivatives of benzol, particularly benzoic acid and its relatives and among the naphthalene derivatives.

TABLE I.

Substances Affecting the Photographic Plate.

Compound.	Wave length of the fluorescence in Ångstrom units.	Visible fluorescence.	Intensity and the position of the maxima and minima.
Potassium iodide	4400–4750	Moderate	Peak at 4550, very faint.
Potassium bromide	4200–4900	Bright	Peak at 4650, faint.
Sodium bromide	2400–5000	Bright	Strong, extends beyond these limits in both directions. Broad region of slightly diminished intensity at 4000.
Strontium salicylate	3950–4900	Bright	Symmetrical, fairly strong
Benzoic acid	2950–5000	Moderate	Not strong, region of diminished intensity at 3900.
p-Sulfone-amine-benzoic acid	2950–3500	Bright	Peak at 3200, faint.
Phenol	2960–5000	Moderate	Strong, peaks at 3080 and at 4850. Broad region of diminised intensity at 3500.
p-Amidophenol hydrochloride	2950–3350	Moderate	Not strong, peak at 3050.
Diphenyl	3450–4500	Bright	Flat even distribution, fairly strong.
Naphthalene	3300–4500	Moderate	Strong, peak at 3460.
β-Naphthalene sodium sulfonate.	3300–4900	Bright	Broad peak at 3900, fairly strong.
β-Naphthalene sodium sulfonate, purified crystals	3300–5000	Bright	Peak at 3500 sloping gradually to the visible, fairly strong.
Naphthalene calcium disulfonate.	3700–4500	Moderate	Faint.
Sodium naphthionate	4100–4700	Bright	Faint.
2,6-β-Naphthol ammonium sulfonate	3700–5000	Bright	Not strong, even.

NOTE.—It is possible that of the other substances listed in Table II there is also a photographic effect from *o*-hydroxybenzoic acid; sodium *o*-hydroxybenzoate; *o*-aminobenzoic acid; benzidine and hexamethylene tetramine triguaiacol.

TABLE II.[1]

The Visible Fluorescence of Organic Compounds.

Substance.	Visibility.	Substance.	Visibility.
acetamide	0	hydrazo-benzene	0
acetanilide	3	diazo-aminobenzene	0
methyl-acetanilide	2	bromobenzene*	2
acetone*	3	*o*-bromo-nitrobenzene	2
acridine	4	ethyl benzene	0
phenyl-acridine	7	iodobenzene*	2
alanine	0	iodosobenzene-*p*-sulfonic acid	4
phenyl-alanine	2	benzene ethylsulfonate	0
phenyl-alanine (from casein)	3	benzene-*m*-sodium disulfonate	8 P
phenyl-alanine hydrochloride	2	benzophenone	7
sodium alizarin sulfonate	0	benzil	6
aminoid peptone		benzyl alcohol*	0
(amino acid N = 60%) beef	0	benzyl aniline	2
aminoid peptone		benzyl chloride*	1
(amino acid N = 50%) casein	2	benzyl cyanide*	3
aminoids (biuret free)		benzyl ethyl ether*	2
casein	0	benzoyl acetone	2
aminoids (biuret free)		benzonitrile*	3
beef	0	benzoyl thymol*	1
amino acid still-residue	1	benzidine	6
diamino-stibene	0	benzidine C	1
amyl alcohol*	1	benzidine 2 H acid	0
iso-amyl iodide*	0	benzidine poly-iodo-acetate	0
aniline*	0	benzidine sulfone	1
diethyl-aniline*	2	benzidine sulfone	
dimethyl-aniline*	6	2 R salt	0
iodo-aniline	0	benzidine sulfone	
m-iodo-aniline*	0	mono-sulfonic acid	0
p-iodo-aniline*	0	benzidine sulfone	
m-nitro-aniline	0	disulfonic acid	0
p-nitro-aniline*	1	benzidine mono-sulfonic	
p-nitroso-dimethyl-aniline	0	acid 2 H salt	0
anthracene	8	benzidine mono-sulfonic	
dibromo-anthracene	7	acid 2 R salt	0
anthraquinone	2	benzidine mono-sulfonic	
anthraquinone sodium sulfonate	4	acid NH_2R salt	0
anthraquinone monosodium sul-		benzidine trisulfonic acid	3
fonate	1	diaceto-benzidine	0
asparagine	0	*m*-diamino-benzidine	
benzene*	3	hydrochloride	1
p-amino-azobenzene	0	1-iodobenzidine hydrochloride	2
amino-azobenzene hydrochloride	0	2-iodobenzidine hydrochloride	2
diamino-azobenzene hydrochloride	0	4-iodobenzidine hydrochloride	0
dimethyl-amino-azobenzene*	0	benzamidine hydrochloride	7 P
p-dimethyl-amino-azobenzene		hydrobenzoin	4 P
o-carboxylic acid (methyl red)	0	benzoic acid	5 P
amino-azobenzene disulfonic acid	0	*o*-aminobenzoic acid	5 P

[1] The figures 0 to 8 under visibility indicate the intensity of the fluorescence. P stands for distinct phosphorescence. Liquids are indicated by an asterisk *.

TABLE II (*continued*).

Substance.	Visibility.	Substance.	Visibility.
m-aminobenzoic acid	0	ethylene bromide*	2
p-aminobenzoic acid	0	ethylene chloride*	1
o-chlorobenzoic acid	5 P	glutamic acid	7
o-hydroxybenzoic acid (salicylic acid)	8	glutamic acid	2
m-hydroxybenzoic acid	1	glutamic acid	0
p-hydroxybenzoic acid	5 P	glutamic acid hydrochloride	0
1,2,5-homohydroxybenzoic acid	0	glycerol*	0
1,2,4-dihydroxybenzoic acid (β-resorcylic acid)	6	glycine anhydride	3
iodo-hydroxybenzoic acid	0	glycine anhydride	0
methyl-*o*-hydroxybenzoic acid ester	8	glycylglicine hydrochloride	0
phenyl - *o* - hydroxybenzoic acid ester	6	glycylglicine	5
sodium-*o*-hydroxybenzoate	3	glycine ester hydrochloride	1
o-iodobenzoic acid	4	glycine ester hydrochloride	0
o- and *p*-iodobenzoic acid	3	glycine ethyl ester hydrochloride	0
iodosobenzoic acid	0	phenyl-glycine	0
o-nitrobenzoic acid	0	dibromo-guaiacol	5
p-nitrobenzoic acid	0	dibromo-*o*-guaiacol potassium sulfonate	0
1,3,5-dinitrobenzoic acid	2	iodoguaiacol sodium sulfonate	0
p-sulfone amine benzoic acid	6	hexamethylene - etramine tri-guaiacol	5 P
sodium benzoate	5	H acid	1
benzaldehyde*	0	dichlorohydrin*	1
p-amino-benzaldehyde	0	hydroquinone	4
hydroxy-benzaldehyde	0	hydroxy-hydroquinone	0
1,2,4-dihydroxy-benzaldehyde (β-resorcyl-aldehyde)	2	dibromo-thymoquinone	0
1,2 - hydroxy - 5 - bromo - benzal-dehyde	8	iodoform	0
bromal hydrate	0	leucine	0
bromobutyril bromide*	1	leucine 60–100	0
camphor	4	leucine 100–130	0
calcium camphor sulfonate	2	leucine 130–150	0
carbon tetrachloride*	3	residue from leucine purification	1
chloroform*	2	mercury ethyl	0
cholesterol	0	methyl alcohol*	0
cinchonidine	4	naphthalene	4
isocinnoline*	3	naphthylene-1,2-diamine	1
creosol*	2	naphthylene-1,2-diamine hydro-chloride	0
o-cresol*	0	naphthylene-1,5-diamine	0
m-cresol*	0	naphthalene boric acid	0
p-cresol	2	bromo-naphthalene*	5
tricresol *	1	α-methyl-naphthalene*	7
cumene	0	β-methyl-naphthalene*	5
cyanacetic acid	0	1,5-dinitro-naphthalene	0
elaidic acid	0	1,8-dinitro-naphthalene	0
ethyl alcohol*	0	α-naphthalene sulfochloride	2
ethylamine hydro-iodide	0	β-naphthalene sulfochloride	1
		α-naphthalene sulfonic acid	5
		β-naphthalene sulfonic acid	6
		β-naphthalene sodium sulfonate	6

TABLE II (*continued*).

Substance.	Visibility.
β-naphthylene sodium sulfonate (Witt method)	7
naphthalene disulfonic acid	5
naphthalene calcium disulfonate	5
1,8,3,6-dihydroxy-naphthalene sodium disulfonate (chromotropic acid chromogen-1)	3
naphthalene sodium trisulfonate (crude)	4
α-naphthol	4
β-naphthol	2
β-naphthol	0
1,4-α-naphthol monosulfonic acid (crude) (Neville and Winther's acid)	2
1,5-α-naphthol monosulfonic acid (crude)	1
2,6-β-naphthol ammonium sulfonate	6
1,4,8-α-naphthol disulfonic acid (crude) (Schollkopf's acid)	0
1,3,8-α-naphthol disulfonic acid (crude)	4
β-naphthol disulfonic acid	1
2,6,8-β-naphthol disulfonic acid, G acid (crude)	6
2,3,6-β-naphthol disulfonic acid, R acid	6
2,6,8-β-amino-naphthol sulfonic acid (crude)	4
1,8,3,6-amino-naphthol sodium disulfonate H (crude)	0
1,8,4,6-amino-naphthol sodium disulfonate K (crude)	1
α-naphtho-cinnoline	5
α-naphthonitrile*	4
β-naphthonitrile	6
β-naphthoquinone monosulfonic acid	0
naphtho-resorcinol	0
α-naphthyl salicylic acid	5
α-naphthylamine	4
α-naphthylamine hydrochloride	4
β-naphthylamine	2
β-naphthylamine chloride	3
dimethyl-α-naphthylamine*	6
phenyl-α-naphthylamine	7
phenyl-β-naphthylamine	7
2,7-naphthylamine sulfonic acid (crude) (Delta acid) (F acid)	4
1,5-α-naphthylamine sulfonic acid (crude) (Laurent's acid)	0
2,6-β-naphthylamine sulfonic acid (crude) (Bronner's acid)	4
2,8-β-naphthylamine sulfonic acid (crude)	6
2,3,6-β-naphthylamine disulfonic acid (crude) (amino R acid)	4
2,6,8-β-naphthylamine disulfonic acid (crude) (amino G acid)	6
naphthionic acid	1
hydroxy-naphthionic acid	4
sodium naphthionate	8
α-aceto-naphthalide	4
β-aceto-naphthalide	6
benzoyl-α-naphthalide	4
acenaphthene	6
p-nitro-anisole	0
phenacetine	4
phenacetolin	0
phenanthraquinone	1
phenanthrene	7
phenetole*	1
p-phenetole sulfonate	5 P
dibromo-phenetole-4-sulfonic acid	0
p-isobutyro-phenetidine	0
phenol	4
phenol (in water 72%)*	3
phenol (in water 8%)*	1
m-aminophenol	0
p-aminophenol hydrochloride	4
p-bromophenol sulfonic acid	1
p-dibromophenol sulfonic acid	0
tribromophenol	5
o-chlorophenol sulfonic acid	3
chloro-nitrophenol	0
2,6-dichloro-phenol-4-sulfonic acid	5
p-iodophenol	0
di-iodophenol-4-sulfonic acid	0
di-iodophenol iodide	0
o-nitrophenol	0
p-nitrophenol	0
o-nitrophenol, condensed with HgO	0
o-nitro-chlorophenol condensed with HgO	0
phenolphthalein	0
diphenyl	6
di-iodo-diphenyl	0
diphenyl-iodo-iodide	0

TABLE II (*continued*).

Substance.	Visibility.	Substance.	Visibility.
diphenyl carbonate	4 P	bromo-pyrogallol-trimethyl ether	6
diphenylamine	5 P	bromo-pyrogallol-dimethyl sulfonic acid	3
diphenylamine hydrochloride	1	quinine hydrochloride	3
methyl-diphenylamine* (crude)	7	quinine sulfate	2
1-phenyl-3-methyl-5-pyrazolone	0	quinoline*	0
3-phenyl-5-chloropyrazole	4	*o*-hydroxy-quinoline	0
hydroxyphenyl mercury acetate	0	resorcinol	4 P
diamino-diphenyl-thio-urea	0	resorcinol dimethyl ether*	0
p-phenylene-diamine	5	tribromo-resorcinol	0
p-aceto-phenylene-diamine	2	di-iodo-resorcinol	0
phenylene - diamino - azo - *o* - toluidine	0	tri-iodo-resorcinol	0
p-phenylhydrazine sulfonic acid	0	terpine hydrate	0
p-amino-acetophenone	1	theobromine	6 P
cinnamylidene-acetophenone	3	thymol	0
pinene*	0	toluene*	3
α-bromo-propionic acid*	0	*p*-bromotoluene*	2
iodo-propionic acid	1	dinitrotoluene*	0
bromo-propionyl chloride*	0	*o*-nitro-toluene sodium sulfonate	1
pyridine*	0	tyrosine	1
pyridine hydrochloride*	1	tyrosine	0
pyrogallol-dimethyl ether barium sulfonate	3	tyrosine and cystine	0
pyrogallol-trimethyl ether barium sulfonate	3	xylene*	4
bromo-pyrogallol-dimethyl ether	6	*o*-xylene*	3
		m-xylene*	2
		1,3-xylenol-4*	4

TABLE III.[1]

The Visible Fluorescence of Dyes.

Substance.	Visibility.	Substance.	Visibility.
acridine	3	benzo blue 3 B	0
acridine orange	0	4 benzo blue	0
phenyl acridine	6	benzo brown G	0
ethyl red	0	benzo fast blue R	0
alizarine dry	0	benzo fast pink 2 BL	4
aniline blue	1	benzo fast scarlet 4 BS	0
anthracene blue	0	benzo fast yellow 5 GL	0
acid anthracene brown R	0	benzo olive	4
anthracene red	1	benzo purpurin	0
anthracene yellow G	2	benzo purpurin 4 B	0
auramine	5	benzo purpurin 6 B	0
aurantia	0	benzo purpurin 10 B	0
azo blue	3	benzo sky blue	5
azo-eosin	0	bismarck brown	0
benzo-azurine	5	bitter almond oil green	0
benzo-azurine G	1	bordeaux G	0
benzo-azurine 3 G	2	brazilin	0
benzo black blue 5 G	1	brilliant cresyl blue	0

[1] The figures 0 to 8 under visibility indicate the intensity of the fluorescence. No dye fluoresced brightly and none was noticeably phosphorescent.

TABLE III (*continued*).

Substance.	Visibility.	Substance.	Visibility.
carminic acid	0	naphthamine blue BXG	0
quinoline yellow	3	naphthamine blue BXR	0
quinoline yellow spirit	1	naphthamine blue JE	0
quinoline red	0	naphthamine blue 3 R	0
chloro-fuchsin	0	naphthamine blue 3 RE	0
chromogen	4	naphthamine brilliant blue B	0
chrysamine G	0	naphthamine brilliant blue BW	0
chrysoidine	0	naphthamine brilliant blue BWO	0
congo red	0	naphthamine brilliant blue G	0
coralline	0	naphthamine brown 8 B	0
coralline alcohol soluble	0	naphthamine brown GX	0
coralline water soluble	0	naphthamine brown 4 G extra	0
crocein	1	naphthamine brown H	0
crystal violet	0	naphthamine brown RB	0
cyanine	0	naphthamine deep black HW	0
diamond black	1	naphthamine direct black C	0
eosin w.	1	naphthamine direct black EK	0
erythrosine	0	naphthamine direct black O	0
fluorescein	0	naphthamine direct black RWK	0
fuchsin f. bac.	0	naphthamine direct brown 2 R	0
gentian violet BP	0	naphthamine fast black KS	0
hematoxylin	0	naphthamine fast black SDE	0
hemalaun dry	0	naphthamine fast black SE	0
hematein	0	naphthamine fast black VE	0
indigo carmine	0	naphthamine fast bordeaux BG	0
iodo-methylene blue	0	naphthamine fast scarlet B	0
iodo-eosine	0	naphthamine fast scarlet R	0
iodine green	0	naphthamine green A	0
malachite green	0	naphthamine green AB	0
methylene blue	0	naphthamine green AG	0
methylene blue 2 B extra	0	naphthamine green B	0
methyl eosine	0	naphthamine green TE	0
methyl orange	0	naphthamine orange 2 R	0
methyl violet	0	naphthamine red H	0
naphthalene red	0	naphthamine scarlet B	0
naphthamine black BN	0	naphthamine violet BE	0
naphthamine black BNN	0	naphthamine violet N	0
naphthamine black GE	0	1,2-naphthoquinone-4,6-sodium disulfonate	0
naphthamine black H	3		
naphthamine black HRE	3	1,2-naphthoquinone-4-sodium sulfonate	0
naphthamine black 2 RE	0		
naphthamine black 3 RE	0	naphthol yellow S	0
naphthamine black 4 RE	0	naphthol green	0
naphthamine black RGE	3	naphthol orange	0
naphthamine blue	0	naphthylamine black 10 B	0
naphthamine blue 7 B	0	naphthylamine black BOO	0
naphthamine blue 12 B	0	naphthylamine black NR	1
naphthamine blue BE	0	neutral red	0
naphthamine blue 2 BL	0	nigrosine base	0
naphthamine blue 2 BX	0	nile blue sulfate	0

TABLE III (*continued*).

Substance.	Visibility.	Substance.	Visibility
orange G	0	rubin	0
orcein	0	safranine (alcohol)	0
phloxin red	0	scarlet red	0
phosphin 3 R	0	solid green	0
ponceau PR	0	sudan III	0
pyronine	0	tropaeolin	0
rapid filter yellow	0	tropaeolin-*o*-resorcine yellow	0
rapid filter green I	0	trypan blue	2
resorcine fuchsine	0	trypan red	1
rosanilin acetate	0	uranin (fluorescent)	2
rose bengale	0		

Summary.

An extended search for a substance which might be available for application in animal experiment (relatively soluble), and at the same time capable of emitting fluorescent rays in the mid-ultra-violet region of the spectrum under the influence of the X-ray, has revealed only sodium bromide as possessing these qualities. Many organic chemical compounds fluoresce brightly in the visible region of the spectrum and a moderate number of them give fluorescence which is capable of blackening the photographic plate.

It has been shown that there are solids, liquids, gases and certain solutions which fluoresce. The phenomenon is not limited to any physical state. The nature of the fluorescence excited in any material, both as to intensity and quality is independent of the quality of the exciting X-rays and dependent on their energy alone.

I wish to express my appreciation to Dr. Paul Lewis for the very considerable interest which he has taken in this problem.

PHILADELPHIA, PENNA.

[CONTRIBUTION FROM THE PHYSICAL CHEMISTRY LABORATORIES OF THE UNIVERSITY OF CAPE TOWN.]

HYDROGEN OVERVOLTAGE.

Criticism of the Papers by MacInnes, Adler and Contieri.[1]

BY EDGAR NEWBERY.

Received June 1, 1920.

In these papers the authors appear dissatisfied with the explanations so far proposed for the influence of the physical condition of the electrode surface on hydrogen overvoltage, and they have carried out certain experiments and restated in a modified form the theory of Möller to account for these changes. Unfortunately, their method of experiment and also certain vital parts of their reasoning are open to most serious objections. It is to be feared that these objections are of such a nature

[1] THIS JOURNAL, 41, 194 and 2013 (1919).