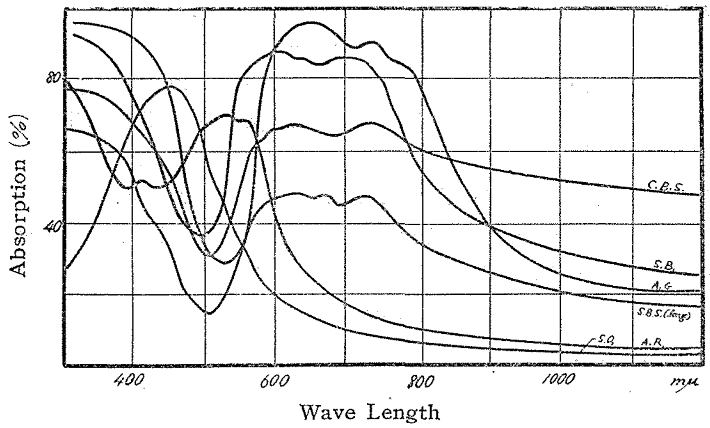
were summarized in Fig. 1. The four pigments, (1)-(3) and **elongated (1),**



which are composed of copper phthalocyanine and its derivative showed similar type of absorption spectra, which which had a wide band of absorption between 5500A and 8000A, and minimum at about 5000A. The slight difference between the original (1) and the elongated one is considered to be ascribed to the transition of inner structures of the particles.

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12. On the Relation between the Color and the Quantity of Iron in Paper Clay

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Clay highlights some of the many important advances which have resulted from the advent of synthetic rubber and the rapid growth of the machine coating of paper. So it is necessary to study the chemical and physical properties of clay, among which its size as well as its color plays the most important role. Of these two, the latter alone will here be treated. The color is mostly affected by the quantity of iron, especially in its ferric form. To determine the quantity of iron in clay the gravimetric procedure is generally preferable, but the colorimetric method is used to determine it in a simpler way. Trace of iron is usually determined colorimetrically with thiocyanate as reagent. Since many factors affect the color shades or the color intensity of the red compound formed, the proper procedure and due consideration of possible interferences are necessary to obtain satisfactory results.

Standard iron solution: Ferrous ammonium sulfate was dissolved in water and some sulfuric acid was added, then the solution was oxidized by

$KMnO_4$. Its concentration was 0.013mg Fe/ml. This solution was used as a standard iron solution.

Reagent: $3N$ ammonium thiocyanate solution.

The time of standing after the addition of reagent: The intensity of the red color of the compound did not change from 5 to 20 minutes after the addition of reagent.

Effect of concentration of thiocyanate upon the color: The color intensity increased with increasing thiocyanate concentration. Therefore in the colorimetric determination of iron it is desirable to use a very large excess of reagent. Under these conditions Beer's law holds over a fairly wide range of iron concentrations.

Influence of acid upon the color: The color was practically independent of the concentration of H_2SO_4 in the range of $0.3l$-n-$1.2N$.

Interfering substances: Al, Ca and Mg did not interfere the color intensity.

Colorimeter: Duboscq type colorimeter.

Sample: An example of chemical analysis of the rock for paper clay is shown in Table 1.

Table 1.

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Ignition loss
83.34	11.14	0.44	1.00	0.27	2.50

Procedure: The rock was pulverized in a agate mortar and was dried at 110°C until a constant weight was attained. A 0.2-0.3g sample was weighed out exactly and was fused; the melt was evaporated to dryness with HCl as usual. Then 5 ml. of $6N$ H_2SO_4 and some quantity of water were added to the residue and it was filtered. The filtrate was oxidized by $KMnO_4$. It was diluted with water to 50 ml. To 5 ml. of this solution, 1 ml. of $3N$ NH_4SCN was added in a 10 ml. mess-flask, which was filled with water up to the mark. It was poured into one of the colorimetric tubes. A control solution was prepared by adding 1 ml. of $6N$ H_2SO_4 and 1 ml. of $3N$ NH_4SCN to 5 ml. of the standard iron solution in just the same way as above. Next it was poured into the other colorimetric tube, and their color intensities were compared.

Results: The total iron in some kinds of the rock for paper clay and two kinds of paper clay were determined. The results obtained are shown in Table 2.

Table 2.

Sample	Fe_2O_3*	Fe_2O_3**
Rock A, grayish black	0.303	0.280

B, gray	0.150	0.154
C, brown	0.158	
D, white	0.094	
clay powder (higher grade)	0.138	
〃 (lower grade)	0.208	

* These are the average values obtained from two samples.

** These are the values obtained after precipitating $Fe(OH)_3$ and $Al(OH)_3$.

The brown or gray-black color of the rock are the deeper, the more the iron content. The whitest and high grade paper clay contains very small quantities of iron. By the proper selection of the rock the color of paper clay will be improved.

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13. Study on High Dielectric Constant Ceramics. (XV)

Coupled Vibration in Electrostrictive Vibrators

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Theoretical analysis of coupled vibration, which can be seen in a mechanical vibrator having more than two modes of vibrations, was considered in previous report (K. Abe, T. Tanaka and K. Uo: *Jour. of the Denki Hyoron*, **39**, No. 12 (1951), 2.), and it was concluded that such theory agrees quite well with the experimental result in the case of $BaTiO_3$ ceramic vibrator having the shape of rectangular plate. The same manner can be applied in the treatment of hollow cylinder or circular disc or cylinder.

Consider a thin hollow cylinder having axial length a and radius r, then the resonant angular frequencies (*r. a. f.*) are given by the next formula when no coupling effect exists between the two vibrations:

$$w_a^2=\frac{\pi^2 E}{a^2\rho}, \qquad w_r^2=\frac{E}{r^2\rho}. \tag{1}$$

If coupling effect is considered, *r. a. f.* become as follows, substituting $p=a/\pi r$:

$$\begin{aligned} w_1^2&=\frac{E}{r^2\rho}\cdot\frac{(p^2+1)-\sqrt{(p^2+1)^2-4p^2(1-\mu^2)}}{2p^2(1-\mu^2)}=\frac{E}{r^2\rho}u_1(p^2,\mu)\\ w_2^2&=\frac{E}{r^2\rho}\cdot\frac{(p^2+1)+\sqrt{(p^2+1)^2-4p^2(1-\mu^2)}}{2p^2(1-\mu^2)}=\frac{E}{r^2\rho}u_2(p^2,\mu)\end{aligned} \tag{2}$$

where μ is the coupling coefficient. Compared with Love's same result about thin hollow cylinder (A. E. H. Love: "Mathematical Theory of Elasticity". Chap. XXIV, p. 546, 4th. ed. 1927), it is concluded that μ is equal to Poisson's ratio σ.