of limit (especially well done), study of monotonic sequences, series of positive terms, comparison and ratio tests, alternating series, the Cauchy condition, uniform convergence, binomial and logarithmic expansions, integral tests, double series, Cesàro sums, Fourier series.

There are several unusual features of the book. (i) The now standard shorthand, such as:

$$\alpha_n \to 0 \text{ if } \cdot \\ \varepsilon > 0;\ EN \cdot |\alpha_n| < \varepsilon \text{ when } n \geqq N,$$

is introduced early, explained thoroughly and used consistently throughout the work. This is a great advantage in conciseness and clarity. (ii) The author divides all (real) series into three classes: convergent (when the sum S_n of the first n terms approaches a finite limit), divergent (when S_n becomes positively or negatively infinite), non-convergent (when S_n approaches no finite or definitely infinite limit). This classification is not commonly used, but is entirely appropriate. It is more discriminating than the usual classification, and notably more precise in such topics as power series and Abel's theorem. (iii) The book contains numerous well-graded and illuminating exercises. These are in part applications of the theory developed, in part elaborations of it; they alone are sufficient to justify the publication.

There are a few matters in which the reviewer fails to see eye to eye with the author. (i) The latter is not entirely consistent in his use of divergence, for he admits (p. 17) the notation $\alpha_n \to +\infty$, he asserts (p. 22) that if $S_n \to S$ then S is called the sum of the series, he later (p. 23, § 2.1) considers that a series has a sum if and only if S_n tends to a *finite* limit. (ii) More figures and better ones would be an aid to the beginner. For instance, the figures (pp. 84, 85) illustrating uniform convergence are not as closely related to the details of the definition as one might expect.[1] (iii) In proving (p. 84) the theorem on term-by-term integration in a finite interval of a uniformly convergent series, the author does not require continuity of the terms of the series, hence needs to *assume* the integrability of the sum of the series; he omits the remark that this condition is automatically fulfilled if the terms of the series are continuous. (iv) In the chapter on Fourier series, the author does not mention the least-square property of the partial sums; this omission is probably due to a desire to save space, but the property is an important one and can be established in a few lines. (v) The only general convergence theorem proved on Fourier series is that (granted integrability of the given function) of the series where convergent represents the average of the limits (assumed to exist) of the function approached from the right and left. This theorem is no shorter to prove and in the judgment of the reviewer much less interesting to the student (and to the physicist!) than the proof of convergence for functions say satisfying Dirichlet's condition, or even for functions that are piecewise smooth.

Despite these and other criticisms, the reviewer considers the book highly useful for undergraduates, especially when it is supplemented by lectures or tutorial instruction, and wishes it a wide-spread use in this country.

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SPECIAL ARTICLES

A METHOD OF EXTINGUISHING THE REFLECTION OF LIGHT FROM GLASS

H. D. TAYLOR discovered in 1892 that a tarnished photographic lens transmitted more light than a new lens. Since his discovery, several workers[1, 2, 3] have investigated means of treating glass surfaces so as to diminish the reflection and consequently increase the transmission of light by the glass.

Recent experiments have led to a method of coating glass with a film which extinguishes reflected monochromatic light. The film is made in such a way that the light reflected from the outer surface is equal in intensity and opposite in phase to the ray reflected from the glass-film surface. Under these conditions no light is reflected.

In order that a film shall have the property of extinguishing perpendicular light the film must fulfil the following two conditions:

(*a*) The substance of which the film is made must have a refractive index n_1, which has a value given by the equation

$$n_1 = n_0 n_g \qquad (1)$$

where n_g is the refractive index of the glass, and n_0 of the medium in which the glass is viewed which is commonly air.

(*b*) The film must have an optical thickness $n_1 t$, which is given by the equation

$$n_1 t = 0.25\,\lambda\,(2a+1) \qquad (2)$$

where t is the thickness of the film and a is zero or an integer. A film having a thickness corresponding to the first order of interference, *i.e.*, a film for which $n_1 t = 0.25\,\lambda$, is far more effective in diminishing reflec-

[1] F. Kollmorgen, *Trans. Soc. Illuminating Engineers*, 11: 220, 1916.

[2] Ordnance Department Document, No. 2037, p. 76.

[3] J. Strong, *Jour. Optical Soc. America*, 26: 73, 1936.

[1] Contrast, for instance, Osgood, Funktionentheorie I (Leipzig, 1928), pp. 97, 98.

tion when *white light* is used than films corresponding to minima of higher orders for which $a = 1, 2, \ldots$ etc.

Built-up films of the soaps of fatty acids[4, 5] have provided a substance which can be treated in such a way as to have the value of refractive index which is required by Eq. (1) for the case of ordinary glass ($n_g = 1.52$) or for any glass of higher refractive index. The films are unfortunately soft and can be wiped from the glass with a cloth. However, they provide an extraordinarily useful tool for studying the application of the phenomena of interference to problems of light reflection.

The substance of which a built-up film is commonly composed is a mixture of a fatty acid and of the soap of a fatty acid. Thus the composition of Y-films of so-called "barium stearate" is about 50 to 80 per cent. barium stearate, and the remainder is stearic acid. When films of this substance are soaked in a solvent for stearic acid, the film is left as a skeleton of barium stearate, with air filling the spaces previously occupied by the stearic acid.

If a film has initially a refractive index $n_1 = 1.50$, and if 50 per cent. of the material is removed without causing the film to shrink in thickness, the refractive index of the skeleton is 1.232. This is the value of n_1, which serves to extinguish the reflection of light from glass $n_g = 1.518$; that is, from glass of the type of ordinary window glass.

Skeleton films can be built of cadmium arachidate, which are better in optical quality than those built of barium stearate. The films are built by spreading arachidic acid in a monolayer on the surface of a bath which is 10^{-4} M cadmium chloride, 10^{-3} M sodium acetate, 1.2×10^{-4} M HCl, pH 5.7. They are built to the desired thickness on both sides of a plate of glass by the ordinary methods used in making built-up films. The thickness of a film having 42 or 44 layers of skeletonized cadmium arachidate is a quarter wave-length of sodium light. The built-up film is soaked for about 2 minutes in alcohol, and then in acetone at 35° C–40° C until the refractive index has decreased to the extinction value.

A film built in this way completely extinguishes the reflection of sodium light, and nearly extinguishes all visible light of other wave-lengths. When a plate of ordinary glass is placed a few inches from a 6,000-lumen sodium vapor lamp, with a black background behind the plate, the glass reflects a bright glare of yellow light, whereas if the glass is coated with a non-reflecting film the coated area appears as black as black velvet. A stripe of this type of film, built on a plate of glass, increases the transmission of light from 92 per cent. for clean glass to 99.2 per cent. for the film-coated glass. When one looks through the glass at the sky or at a sheet of white paper, the stripe has the appearance of clean glass, and the clean glass on either side of the stripe appears to be slightly smoked.

The difference in reflection is particularly striking in the case of the type of glare which prevents an observer from seeing objects which are behind a glass window. For example, one half of the glass cover of an instrument meter was coated with a non-reflecting film, and the contrast between the coated half and the uncoated half was so striking that observers seeing this instrument for the first time were deceived by the illusion that there was no glass on the film-coated half.

A paper describing the full details of this work will be published in the near future.

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[4] K. B. Blodgett, *Jour. Am. Chem. Soc.*, 57: 1007, 1935.

[5] K. B. Blodgett and I. Langmuir, *Phys. Rev.*, 51: 964, 1937.

CITY AIR SEARCHED FOR SULFUR FUMES

RESULTS of a 15-month survey to determine the *average* amounts of sulfur gases in the air of American cities, long a subject of speculation and dispute, are announced by Air Hygiene Foundation and Mellon Institute. The average amounts of sulfur fumes found in 25 cities studied were comparatively small.

More than 50,000 separate air tests were made by six chemists driving a fleet of cars equipped like "traveling laboratories." They canvassed industrial and residential centers throughout the East, South and Midwest, from August, 1936, to October, 1937. Most of the tests, covering all hours of day and night and all seasons of the year, were made in five metropolitan districts. The five, in the order of their sulfur dioxide pollution, are given in Table 1 (figures indicate parts of sulfur dioxide per million parts of air).

TABLE 1

City	Within 15-mile radius of center of city	
	Average	Maximum
St. Louis—East St. Louis ...	.128	2.266
Pittsburgh	.057	.897
Detroit	.028	.396
Philadelphia—Camden	.027	.424
Washington	.009	.290

The above figures are of no significance from a public health standpoint, according to hygienists connected with the investigation. That is, "in the concentrations found, the contaminants do not exert harmful physiological effects."

The survey showed that the home fires are among the large contributors to sulfur pollution, particularly in districts using coal of high sulfur content. The type of coal burned in a locality was mirrored in the