Letters to the Editor

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Remarkable Optical Properties of the Alkali Metals

I DESCRIBED in the *Philosophical Magazine*, about fifteen years ago, the high transparency for ultra-violet light of thin films of sodium and potassium, deposited by condensation at liquid air temperature, and their complete opacity for visible light. A resumption of the work has brought out some extraordinary properties.

A film of potassium, several wave-lengths in thickness, through which the sun is quite invisible, transmits about 25 per cent of the light included in the spectrum range 3000–1860 A.; the reflecting power from 3000 A. to 2700 A. is about 75 per cent, which means that practically no energy is absorbed, thick and thin films having equal transmitting power in this region. Below 2700 A. the reflecting power falls off very rapidly, soon reaching a value less than that of the bulb of fused quartz. But the most remarkable property is that interference bands are found in the spectrum of the reflected light. An end-on hydrogen tube was used as a source, and the film thickness increased by small steps, a spectrum being taken for each thickness. The dark bands entered from the short wave-length side and accumulated in the spectrum, orders so high as the fifth recording before the opacity became too great.

The filament of a tungsten lamp was invisible through a film which gave only two orders, the transmission of visible light being less than 1/100,000. Films of more than double this thickness gave very distinct interference bands, which means that the ultra-violet light, after two transmissions through the film, has still sufficient intensity to interfere with the light reflected from the first surface. The interference bands cannot be driven into the region above 2700 A., as the reflecting power of the first surface is too high to permit of interference, the bands being found only in the region of low reflectivity. In this region potassium has optical properties resembling those of selenium and the aniline dyes, the conducting electrons appearing to be without influence.

It seems probable that it will be possible to determine the dispersion in this region by the direct observation of the Brewsterian angle of polarisation, and experiments are now in progress along this line. All the alkali metals have now been examined, the transmission region moving down the spectrum as we pass from cæsium to lithium.

With cæsium the transmission band begins at about 4300 A., the films appearing of a blue-violet colour by transmitted light, of a purity equal to that shown by a strong solution of cuprammonium or dense cobalt glass. The film thicknesses are being determined by depositing a circular patch on the inner wall of a bulb, measuring its opacity to visible light and then opening the bulb and determining the amount of metal by titration with phenolphthalein. Experimental determinations of n and κ by the customary methods of metal-optics will be commenced shortly for the region of high reflecting power.

In the earlier work, it was reported that these films were unstable at room temperature, breaking up in a few minutes into globules and becoming almost perfectly transparent. I now find that if the quartz bulb is thoroughly out-gassed before the metal is distilled into it, the potassium films are permanent for several days, especially if moderately thick. A thin-walled quartz bulb with such a film makes a very useful filter for spectroscopic work; the sun's disc is invisible through it, yet we can photograph the solar spectrum through it with an exposure of only about four times normal exposure, the spectrum extending from a little above H and K to the extreme end. The transparency of such a film is nearly uniform as far down as the aluminium line 1862 A., and the lower regions are now being examined with a vacuum spectrograph.

R. W. WOOD.

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Baltimore.
March 20.

March 28.—Supplementing my letter of March 20 on the remarkable optical properties of the alkali metals in the ultra-violet region, I am now able to state that my prediction that potassium would show a Brewsterian angle of plane polarisation in the region below 2700 A. has been verified. The angle found for 2500 A. was 37°, which makes the refractive index $n = 0{\cdot}75$. I am not yet sure how accurately the angle can be determined, or how complete the polarisation is, but the intensity ratio of the two images obtained with a quartz Rochon prism was 1 : 120. The images had equal intensity in the visible and near ultra-violet.

Total reflection is thus to be expected for angles of incidence greater than 50°. This too was verified, at least in part, though I have not yet secured a sharply defined angle. At normal incidence the reflection at wave-length 2200 A. is of the order of 2 per cent, and the first few photographs taken indicate that a rather high value sets in for angles greater than 45°—though the increment seems to be gradual as the angle increases above this value. Better results are expected when more nearly plane reflecting surfaces are secured.

The angle of polarisation shows thus far no evidences of dispersion, which is perhaps to be expected, as the dispersion of the metal in the visible region is extremely small, as shown by Duncan, from measurement of principal incidence angles and azimuths.

Interference maxima and minima up to the fifth order appear in the spectrum of the reflected light between $\lambda = 2100$ and 3000 (not 2700 as reported in my earlier letter).—R.W.W.

Absorption Spectrum of Vitamin A at Low Temperatures

WE have been trying to devise more precise physical criteria for the recognition of biologically important molecules. Obviously, the only ultimate test for such a molecule is its action on living organisms. Physical tests can, however, be used as a guide to decide whether it is worth while to apply biological tests.

The physical criterion which has proved most valuable in this field is the absorption spectrum of the complex molecules, but this has nearly always been measured in solution at ordinary temperatures.