USE OF LUMOGEN 640 AS AN OPTICAL CONVERTER IN PHOTOMETRY

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Unselective detectors have often to be used in measuring monochromatic radiation in the UV and visible regions. Ordinary thermopiles have various disadvantages: small detecting area, slow response, and need for careful thermostatic control or compensation. A thermopile can be replaced by a photomultiplier with an optical converter (phosphor whose quantum yield is constant over a wide range). Then the incident radiation is converted to a proportionate amount of luminescence, which is recorded by the photomultiplier. Sodium salicylate is often used, but this is restricted to wavelengths shorter than 350 nm [1].

We have used lumogen red 640 to transform visible and UV radiations. This has its emission peak at 640 nm and a quantum yield of nearly one over the range 240 to 580 nm [2].

Figure 1 shows the design of the photometer attachment. The dye layer is about 1 mm thick and absorbs wavelengths <600 nm completely; it is deposited as a suspension in acetone directly on the end window of the photomultiplier, which is covered by a tufnol sheet 1 mm thick, itself covered on the outside by black paper. The type of photomultiplier is not important, provided that it has adequate response at 640 nm (FÉU-14, FÉU-38, etc.). We required a system for continuous recording with minimum loss of light. This was achieved by inserting a plane-parallel quartz plate set at 45° to the beam, which reflects about 5% [3]. Of course, in other cases one could use a half-silvered mirror or could direct the beam straight to the converter.

The spectral response of such an attachment could differ from that of the lumogen 640, because the reflectivity of the dye is dependent on wavelength [2], as is that of the quartz plate [3]. Moreover, the luminescence has to pass through the phosphor before reaching the photomultiplier, and the absorption and scattering will be dependent on the distance travelled in the layer. The absorption coefficient of the dye is wavelength-dependent, so that distance will also vary with the wavelength. We therefore measured the spectral response of the system of Fig. 1 as attached behind the exit slit of a ZMR-3 monochromator (slit

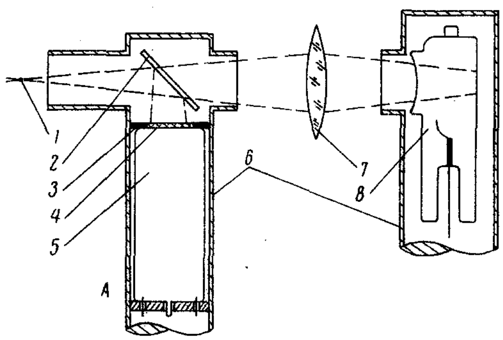

Fig. 1

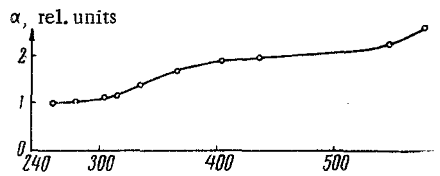

Fig. 2

Fig. 1. Photometer attachment (A) and calibration system: 1) light source; 2) plane-parallel quartz plate; 3) tufnol plate; 4) lumogen 640 layer; 5) photomultiplier; 6) metal jacket; 7) quartz lens; 8) F-4 photocell.

Fig. 2. Response of the photometer attachment.

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width 0.2 mm, PRK-4 lamp), the light reflected from the quartz plate falling completely on the dye layer. The light transmitted by the quartz plate passed to an F-4 photocell, which had previously been calibrated to 5%.*

Figure 2 shows the response of the attachment, which was measured to 10%. The sensitivity is shown in relative terms, since the absolute response is dependent on the photomultiplier, the operating conditions, and the quality of the quartz plate. A very similar curve was obtained when the photocell was replaced by a thermopile from the Agrophysical Institute, Leningrad. Figure 2 shows that the response varies by a factor 2.6 in the range 250-580 nm and increases with wavelength; the curve does not coincide with that for the quantum yield of the dye, mainly because the loss of luminescence by scattering and absorption itself varies with wavelength. This attachment is very convenient, since it is very sensitive, is fast in response, has a large receiving surface, and can cover the range 250-580 nm. The variation in sensitivity over the spectrum is not very great and is much less than that of a photomultiplier. The proportionality to the light flux is especially convenient in photochemical and spectral studies.

LITERATURE CITED

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