SOME NEW IMMERSION MELTS OF HIGH REFRACTION

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There have been difficulties in finding good media of high refraction for refractive index determinations with the microscope. Up to an index of about 2.1 good melts of iodine and piperine can be obtained. Above this value melts of selenium and sulphur have been used, and for still higher values melts of selenium and arsenic trisulfide.

However, these melts are not very convenient to use; they are highly colored and many are opaque for all but the red rays. If, therefore, the powder to be examined is itself colored, or nearly opaque, which often is the case for substances with high refraction, it is almost impossible to obtain satisfactory results. For this reason better melts of high refraction (above 2.3) are highly desirable.[1]

The halogen compounds of thallium will render good service if used as high refraction immersion media. They are isotropic and very transparent; they are easily prepared and melted on an object glass (or better, between two cover glasses) over a low flame.

TlCl can be precipitated from a solution of a thallous salt (e.g. Tl_2CO_3) by the addition of a soluble chloride (e.g. KCl). It melts at 426°C between two cover glasses and recrystallizes on cooling to a limpid, thin, continuous sheet consisting of homogenous, isotropic crystals. Its index of refraction for different wave lengths is given in Fig. 1.

TlBr is prepared in the same way as TlCl. It melts at 450°C. It is colorless in thin sheets. Its index of refraction is shown in Fig. 1.

TlI is also prepared in the same manner as TlCl. It melts at 435°C and will on cooling crystallize in a cubic modification, which, however, at about 170°C inverts into an orthorhombic modification (see later).

* This investigation was carried on in Dept. of Mineralogy and Petrography, Harvard University.

[1] For literature references, see E. S. Larson, *Microscopic determination of minerals, U. S. G. S. Bull.* **679,** 1921.

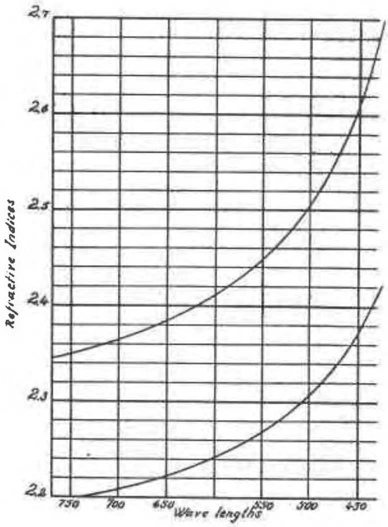

FIG. 1. The refractive indices of TlCl (lower curve), and TlBr (upper curve) for different wave lengths.

Mixed Crystals of TlBr and TlI. TlBr and TlI form homogenous mixed crystals in all proportions and these crystals are isotropic and suitable for immersion media. Precautions should be taken in the preparation of these compounds. They are easily obtained by direct precipitation of the mixed crystals by adding a solution of a mixture of KBr and KI (in the desired proportions) to a cold solution of Tl_2CO_3.

If this precipitation is made in hot solutions the precipitated mixed crystals will not correspond in composition to that of the added solutions, but owing to the relatively high solubility of TlBr in hot water, the crystals will be richer in iodine than the solution.

If on the other hand this precipitation is carried out in cold solutions, TlBr is so insoluble that practically all of the added bromine ions will be precipitated, and the resulting mixed crystals correspond exactly to the added solutions. The resulting mixtures are good immersion media whose indices of refraction cover the range between 2.4 and 2.8 (Na light), and they have a greater transparency than any other of the proposed immersion media of equal refractive power (Fig. 2).

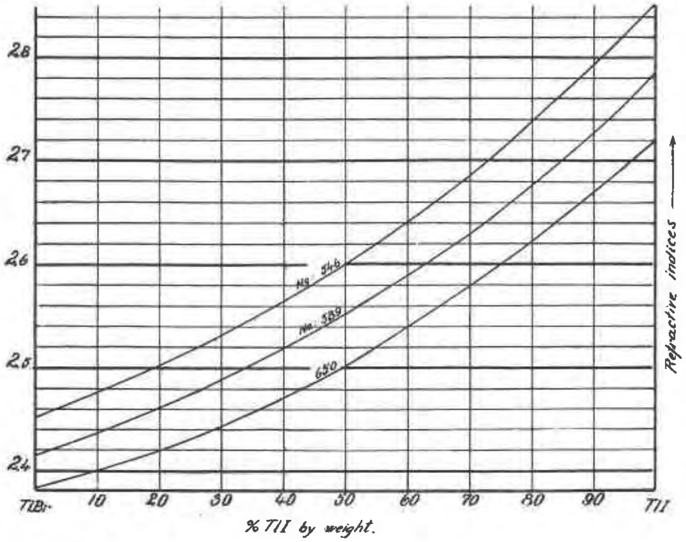

FIG. 2. The refractive indices of the mixed crystals of TlBr–TlI for three different wave lengths.

The bromine-rich crystals are transparent for almost all kinds of light, whereas the iodine-rich mixtures are opaque for the violet and blue rays. This does not mean, however, that the iodine-rich crystals are inconvenient to use, or that they are only semi-transparent for the longer wave lengths. The fact is, these compounds have a very sharp absorption border, and thus even in the iodine-rich crystals, though they are quite opaque for the indigo-blue rays, are almost as transparent as glass for the yellow sodium light. Even the green mercury light passes through them very easily. Fig. 3 shows graphically the values of the wave lengths

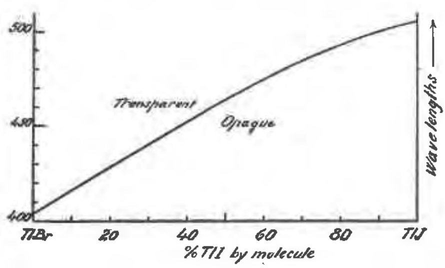

FIG. 3. The approximate position of the absorption border of the mixed crystals of TlBr–TlI.

for which the different mixed crystals very suddenly become opaque.

It should be added that the pure iodide and the iodide-rich mixed crystals are not stable in the cubic modification at ordinary temperatures. They invert into a birefringent (orthorhombic) modification,[2] but even in the mixed crystals with 80% TlI this inversion goes on so slowly that the crystals often remain cubic for days, and no precautions need be taken. The pure TlI, however, will invert more rapidly, and at a somewhat elevated temperature it changes completely in a few seconds. If, however, the melt is chilled (by pressing against a wet handkerchief) the crystals will remain cubic long enough for the necessary investigations with the microscope.

[2] This should not be confused with an anomalous birefringence which now and then appears in the quickly cooled melts. As this birefringence is very weak, it does not involve any further difficulties in the determination of the refraction.