

## POLYHALIDES CONTAINING FLUORINE

Sir:

The literature contains no evidence of the existence of polyhalides containing fluorine, save a mention by Cremer and Duncan [*J. Chem. Soc.*, **133**, 2243 (1931)], in a study of the dissociation pressures and other properties of the polyhalides, of the absorption of iodine bromide by cesium fluoride. On the basis of absorption taking place, they concluded that a compound, probably having the formula  $\text{CsFIBr}$ , was formed.

Several years ago work was started in this Laboratory on the preparation of polyhalides containing fluorine. We have found the following four methods for the preparation of alkali polyhalides containing fluorine.

(1) To a saturated solution of the alkali fluoride one equivalent of iodine is added and the solution chlorinated to the disappearance of the iodine color. On cooling crystals which were very nearly homogeneous were obtained.

(2) The same process as (1) with the modification of using a solution acidified with hydrochloric acid gave a better yield. Recrystallization of the products from either of these methods gave homogeneous anisotropic needle-like orange crystals.

(3) A mixture in the proportion of one molecule of alkali fluoride to one atomic weight of iodine was intimately mixed by grinding and chlorinated to constant weight. The final product was an orange-yellow solid which on recrystallization from water gave a good yield of the same orange-yellow crystals as before.

(4) To the acidulated saturated solution of the alkali fluoride was added a slight excess of an aqueous solution of iodine trichloride. The same orange-colored polyhalide immediately separated as gleaming needles.

Adsorbed water was carefully removed before analysis. Since the crystals tend to lose halogen, it is best to keep them in tightly stoppered bottles. The potassium salt is very unstable and so far we have been unable to get consistent analyses of it. However, the rubidium and cesium salts are quite stable, decomposing in the open air to white salts of the corresponding fluorides, respectively, at approximately  $300^\circ$ , and well above  $300^\circ$ .

*Anal.* Calcd. for  $\text{CsFICl}_3$ : Cs, 34.49; Cl, 27.62; I, 32.96. Found: Cs (perchlorate method), 34.27, 34.33; Cl, 27.61, 28.06; I, 33.38, 32.81.

The melting point of the  $\text{CsFICl}_3$  in a sealed tube is  $194^\circ$ . The crystals exhibit parallel extinction and have a specific gravity of 3.565.

*Anal.* Calcd. for  $\text{RbFICl}_3$ : Rb, 25.30; Cl, 31.50; I, 37.58. Found: Rb, 25.27, 25.47; Cl, 31.46, 31.52; I, 37.52, 38.05.

The melting point of the  $\text{RbFICl}_3$  in a sealed tube is  $172^\circ$ . It has a specific gravity of 3.159 and exhibits parallel extinction under crossed nicols.

The potassium salt has the same crystal form as the others and qualitative analysis shows the presence of potassium, chlorine, fluorine and iodine. The investigation of this and other polyhalides containing fluorine is being continued and will be reported in detail later.

MORLEY CHEMICAL LABORATORY  
WESTERN RESERVE UNIVERSITY  
CLEVELAND, OHIO

HAROLD SIMMONS BOOTH  
CARL F. SWINEHART  
WILLIAM C. MORRIS

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### THE ATOMIC WEIGHTS OF H(2) AND Be(9)

*Sir:*

Among the lighter elements there are two whose atomic weights are of especial interest at this period, H(2) and Be(9). Since H(2) is a probable nuclear building unit and is also the simplest complex nucleus reported to date (excluding neutrons) an accurate knowledge of its atomic weight gives a measure of the interaction energy of two protons and one electron, which energy may be a fundamental unit of the nucleus.

Another such unit may be the proton-electron interaction energy obtainable from the difference in mass of the neutron(1) and an atom of H(1). The accurate mass of Be(9) is necessary in calculating the mass of the neutron(1) [Chadwick, *Nature*, Feb. 27, 1932].

Until these atomic weights have been accurately determined we may predict values, that for H(2) being obtained by a simple calculation, based on the assumption that the lighter  $4N + 2$  elements contain  $N$   $\alpha$  particles and one H(2) nucleus. Aston [*Proc. Roy. Soc. (London)*, **A115**, 487 (1927)] gives for the packing fractions of Li(6) and B(10),  $2.00 \pm 0.10$  and  $1.35 \pm 0.05 \times 10^{-3}$  mass units (probable errors are assumed to be  $\frac{1}{3}$  maximum allowable error). Using the packing fraction for helium,  $0.54 \pm 0.03$ , we obtain from the data for Li(6)

$$\begin{aligned} 4(0.54 \pm 0.03) + 2A_1 &= 6(2.00 \pm 0.10) + D_1 \\ \text{or } A_1 &= (4.92 \pm 0.36) + D_1/2 \end{aligned} \quad (1)$$

and for B(10)

$$A_2 = (4.59 \pm 0.37) + D_2/2 \quad (2)$$

where  $A_1$  and  $A_2$  represent the packing fraction of H(2) and the  $D$ 's the mass defects of Li(6) and B(10) with respect to He(4) and H(2). Although these equations do not uniquely determine the packing fraction of H(2), they set a lower limit to its atomic weight at  $(2.0098 + D_1 \pm 0.0007)$  from (1) and  $(2.0092 + D_2 \pm 0.0007)$  from (2). From a consideration of the binding energies in some of the lighter nuclei, we may estimate values for the mass defects of Li(6) and B(10) to be  $D_1 = 1.2 \pm 0.4$  and  $D_2 = 2.4 \pm 0.6 \times 10^{-3}$  m. u. These values give H(2) an atomic weight of 2.0110