

10.5: Bromine Trifluoride as a Solvent

WARNING

Bromine trifluoride is a toxic, colorless, and corrosive liquid with a pungent choking smell that is soluble in sulfuric acid but explodes on contact with water and organic compounds. Vapors severely irritate and may burn the eyes, skin, and respiratory system. The liquid burns all human tissue and causes severe damage.

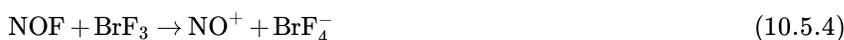
Bromine trifluoride (BrF_3) has a liquid range similar to water ($M_p = 8.8\text{ }^\circ\text{C}$ and $B_p = 127\text{ }^\circ\text{C}$), and like water it auto ionizes, (10.5.1).



The products, like those of water's self-ionization, are an acid (BrF_2^+) and a base (BrF_4^-). However, unlike water, BrF_3 reacts with fluoride acids and bases not proton acids and bases. Thus, in BrF_3 a base is a salt that provides F^- , i.e., potassium fluoride (KF) is a base in BrF_3 solution in the same manner as potassium hydroxide (KOH) is a base in water. The product from the reaction of a fluoride donor salt with BrF_3 is the formation of the conjugate base, BrF_4^- , (10.5.2).



Other examples of this type of reaction include:



By analogy, an acid in BrF_3 solution is a compound that acts as a fluoride (F^-) acceptor, i.e., a Lewis acid, (10.5.5).



Exercise

What are the products from the reaction of HF with BrF_3 ?

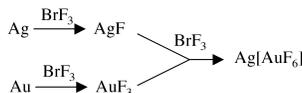
Answer



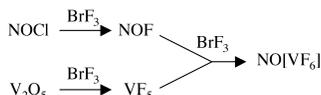
Bromine trifluoride as a fluorinating agent

Bromine trifluoride is a strong fluorinating agent that is able to convert a metal (e.g., vanadium) to its associated fluoride compound, (i.e., VF_5). A wide range of salts and oxides may be converted to fluorides with the metal in a high oxidation state. However, it should be noted that BeO , MgO , and Al_2O_3 form oxo fluorides rather than the fluoride.

The reaction of silver with BrF_3 yields the monofluoride, while the same reaction with gold yields the trifluoride, Eq. If the reactions are combined in BrF_3 solution a mixed metal fluoride salt is formed.



A similar reaction occurs with NOCl and V_2O_5 .



Exercise

What are the products from the reaction of BrF_3 with (a) Sb_2O_5 , (b) KCl , and (c) a mixture of Sb_2O_5 and KCl ?

Answer

(a) SbF_5 , (b) KF , and (c) $\text{K}[\text{SbF}_6]$.

Bibliography

- J. H. Simons, *Inorg. Synth.*, 1950, **3**, 184.

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