

## Low Recovery of Silver in Aqueous Certified Standards

Due to silver's minimal solubility in the presence of trace amounts of chloride, silver will have the tendency to reduce into the elemental form and precipitate out of solution especially when exposed to light. It is recommended to preserve the standard or sample with hydrochloric acid in enough concentration to form the soluble silver chloride complex. Because the  $K_{sp}$  of silver chloride is  $1.77 \times 10^{-10}$ , about 2.9 mg of AgCl will dissolve in a liter of water; therefore, adding excessive amounts of chloride may cause precipitation of silver as well. It is the general recommendation to keep the silver concentration below 100 ppb with a 0.5% (v/v) HCl preservation. If increased concentrations of silver are necessary increase the HCl concentration to 2-10% (v/v) or use only 2-5% (v/v) HNO<sub>3</sub>. When using only nitric acid for preservation, if platinum or other precious metals are present they may give trace amounts of chloride causing silver precipitation; therefore, use chloride free precious metal standards or preserve with above recommendations of HCl preservation. Hydrochloric preserved silver solutions are stable up to 60 days, where nitric preserved solutions are stable up to 4 months. Below are some additional ions that form a precipitate with silver without a nitric acid matrix:

Arsenate, arsenite, bromide, iodide, carbonate, chromate, cyanide, iodate, oxalate, oxide, sulfate, sulfide, tartrate, and thiocyanate