TIN-NICKEL ALLOY PLATING

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Characteristics of the Deposit:

The tin-nickel alloy deposit consists of 65% tin, 35% nickel, plus or minus 2 to 3% either way. This composition represents the atomic percentage SnNi (theoretically 66.91% Sn), and the deposit remains remarkably constant in composition over a wide range of operating conditions and solution variables.

The alloy, when plated on a polished or bright metal, is often sufficiently bright to be used as is; and, if not, a very light color-buffing suffices. It is highly corrosion- and tarnish-resistant. It is not sacrificially protective to steel, so that, for best results, it should be plated in sufficiently heavy thicknesses to be substantially free of porosity. In color the tin-nickel alloy is much warmer than chromium, possessing a faint pinkish cast which gives it a very pleasant appearance.

The hardness of the plate is intermediate between those of nickel and chromium. The alloy is moderately ductile, but not sufficiently so to permit much fabrication after plating. It is free of internal stress, however, and is not at all subject to spontaneous cracking or flaking. Nor is there any difficulty in building up thick deposits which are crack-free. The tin-nickel deposit is almost completely unaffected either by ordinary atmospheric exposure or by most common reagents. Failures which do occur are generally due to porosity rather than to corrosion of the deposit itself. Surprisingly enough, for a decorative and hard finish, the plate is fairly easily solderable. It is finding application in the field of printed circuitry.

The tin-nickel alloy should normally be considered as a final finish, although it is possible to plate chromium over it. Over steel and ferrous metals a copper or bronze undercoat should be used. The solution has excellent throwing power and the anode and cathode efficiencies are practically 100%.

Solution Composition:

Stannous chloride anhydrous ($SnCl_2$)	6.5 oz./gal.
Nickel chloride ($NiCl_2 \cdot 6H_2O$)	40.0 "
Ammonium bifluoride (NH_4HF_2)	7.5 "
Ammonium hydroxide (NH_4OH)	to pH 2.5

	Make-up	Control Limits
Stannous tin	4.0 oz./gal.	3.5- 5.0 oz./gal.
Nickel	9.8 "	8.0-11.0 "
Total fluorine	5.0 "	4.5- 6.0 "
pH		2.0- 2.5 "

The pH can be adjusted by additions of ammonium hydroxide (to raise) or hydrofluoric acid or ammonium bifluoride (to lower). The total fluorine should be at least as high as the total tin (stannic plus stannous). This will tend to rise with the age of the bath; the stannic tin is originally about zero but increases during the life of the solution.

Equipment:

Average current density is 25 amperes per square foot, at about 2 to 3 volts. An allowance of 4 volts at a still tank is ample; barrels require more.

Tank:

Lucite, Neoprene, Koroseal, or rubber-lined steel. Not all rubber linings are suitable; the free sulfur and filler content should be low. Heating may be by graphite or nickel coils or heavily nickel plated coils or immersion heaters. Temperature of operation is 150°F. Piping, pumps, filters, etc. may be Neoprene lined or of nickel or Lucite. Nylon may be used for filter cloths and anode bags.

Good ventilation is required and workmen should wear rubber gloves and avoid direct breathing of the vapors, which contain HF.

Anodes:

Nickel anodes are used and the tin content maintained by regular additions of anhydrous stannous chloride. Depending on the degree of drag-out, the consumption of this chemical will be approximately 3.8 lbs. per 1,000 ampere-hours.

Separate anodes of tin and nickel can be used (in a ratio of about 1:2) and hung from the same bus bar. Dual anode circuits are not required. The anodes should be bagged with Nylon, and should be removed during idle periods. Nickel anodes, on the other hand, should be left in the solution until consumed.

Preparing the Solution:

The plating tank is filled to two-thirds of its volume with water and the temperature raised to about 150°F. The required amounts of nickel chloride and ammonium bifluoride are dissolved, in the order given. After everything is dissolved, but not before, the stannous chloride is added and dissolved with stirring. The pH of the solution is then raised to between 2.0 and 2.5 by the addition of ammonium hydroxide, using papers to determine pH (glass electrode is not suitable in fluoride soultions). The solution is filtered through activated carbon. The increase in volume caused by the addition of the salts will probably have brought the solution up to its correct final volume, but if not, water is added. The solution must be dummied for a few hours, until satisfactory deposits are obtained, and is then ready for use.

During operation the pH of the solution should be between 2.0 and 2.5; this may be estimated colorimetrically by means of papers.

Operation and Control:

The important things are: cleanliness, freedom from impurities, and control of the fluoride ion. Temperature should be controlled fairly closely, 150°F. being the optimum. Frequent filtration will keep the solution free of suspended matter, and care in operation and the use of high quality chemicals and anodes will ensure its freedom from metallic contamination. The bath is a solvent for most metals; work therefore should not be left in the tank with the current off, and extra care should be taken to avoid dropping work into the tank. Purification steps are available to remedy excessive contamination, but the necessity should be avoided as much as possible.

The appearance and the brightness of the deposit depend to a great extent on the fluoride content; and the need for adjustments may be estimated by Hull cell tests. Fluorides are lost by evaporation and dragout. They may be replaced by addition of hydrofluoric acid or ammonium bifluoride or fluoride.

At a current density of 25 amperes per square foot, 0.0005" of tin-nickel alloy is deposited in about 15 minutes.

Stripping:

Stripping is usually unnecessary, since rejects may simply be replated. When essential, the deposit can be stripped in concentrated phosphoric acid at temperatures from 275 to 400°F. This reagent does not attack copper or brass, but will etch steel. Reverse current in sulfuric acid (25%) may also be used. Proprietary strippers are also available.