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THE ELECTRODEPOSITION OF LEAD-TIN ALLOYS

Summary

(The details of this investigation were published in an article by W. Blum and H. E. Haring in the Trans. Amer. Electrochemical Society 40, 147; 1931.)

Alloys of lead and tin have been applied successfully by the Navy Department for lining the air-flasks of torpedoes, and upon torpedo fittings. The bath for this purpose is prepared by operating a lead fluoborate solution with tin anodes until the desired cathode composition is secured, after which anodes of a suitable lead-tin alloy are employed. The lead fluoborate solution may be prepared according to the following formula, based on commercial materials:

	g/l	oz/gal.
Basic lead carbonate.....	142	19
50 per cent hydrofluoric acid..	240	32
Boric acid.....	106	14
Glue.....	0.2	0.025

Such a solution is approximately normal in metal, and 1.5 N in total fluoboric acid (HBF_4).

A study of these solutions led to the following conclusions:

1. Lead and tin have nearly equal potentials in fluoborate solutions, but under similar conditions the tin appears to have the lower potential, that is, the greater solution pressure.

2. Lead or tin may each displace the other from fluoborate solutions, depending upon their respective metal ion concentrations.

3. Solutions which are 1.0 N in metal and 0.5 N in free HBF_4, when agitated with tin or lead, reach equilibrium at about 0.81 N Sn and 0.19 N Pb, because then the two metals have the same potential. This equilibrium is not affected by glue, but is influenced appreciably by the acidity and total metal concentration.

4. The cathode efficiencies under normal conditions are so nearly 100 per cent that the composition of the deposits can be calculated from the weight of metal deposited by a given quantity of electricity. The latter may be measured with a lead or copper coulometer.

5. The composition of the deposits obtained under otherwise similar conditions depends upon the metal ratio in the solution. The ratio of the metals in the deposit is the same as that in the solution, only when the solution has the equilibrium composition as above defined.

6. Increasing the current density in solutions of low tin content increases the tin content of the deposit.

7. The presence of glue has the same effect upon the metal ratio in the deposit as has an increase in current density.

8. The composition of the deposit is not influenced by that of the anodes, except as these cause changes in the solution.

9. Continuous operation with anodes containing more or less tin than corresponds to the equilibrium solution (81 equivalent per cent or 71 weight per cent of tin) causes the formation of deposits differing from the anodes always in the direction of this equilibrium. Thus if the anodes contain less than 71 weight per cent of tin, the deposits will contain more tin than the anodes, and vice versa.

10. To produce deposits containing about 50 weight per cent of tin, the solution may be prepared by electrolyzing a lead fluoborate solution (as previously described) with tin anodes, until as determined by calculation or analysis, the deposit contains nearly the desired tin content. During this operation the solution should be agitated or at least frequently mixed. Lead-tin anodes are then used which contain somewhat less tin than is desired in the deposits. A current density of 0.5 to 1.5 amp./dm^2. (4.7 to 14 amp./sq.ft.) may be employed.

11. Deposits of lead and tin have a finer crystalline structure than lead or tin deposited under similar conditions.

12. In the presence of glue the deposits are still finer grained.

The above conclusions, based on laboratory experiments, are confirmed by observations upon the plant operations.