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ELECTRODEPOSITION OF NICKEL

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6 Claims. (Cl. 204—49)

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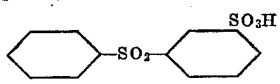
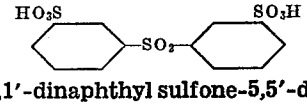
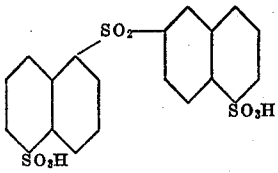
This invention relates to the electrodeposition of nickel from an aqueous acid bath.

The object of this invention is the electrodeposition of a bright ductile nickel plate having good bond to the basis metal. This object can be achieved by the addition of sulfonic acid derivatives of aryl sulfones to an aqueous acid nickel bath.

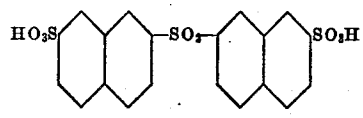
These compounds are listed in Table I with their optimum concentration in baths prepared from nickel sulfate, nickel chloride and boric acid and containing about 75 g./l. Ni, 15 g./l. Cl and 35 g./l. H_3BO_3. The temperature of the plating solution can range from room temperature to boiling and preferably from room temperature to 60° C., ordinarily 55° C. The pH of the solution may vary between 1.5 and 6 and preferably between 2 and 5. The current density generally varies between .5 and 5.5 amp./dm.^{2}. Ordinarily about 4 amp./dm.^{2} is employed at a pH of 3.5 and a temperature of 55° C. Higher current densities may be used at higher metal content, or higher temperature, or lower pH, or with increased agitation.

The presence of other inorganic salts such as NH_4 and Na salts does not interfere with the beneficial action of these organic compounds as long as inorganic materials are present in such amounts which are common in ordinary white nickel baths. Thus the invention is not limited to any specific nickel plating bath and can be used in double nickel salt baths or in straight chloride baths as well as in the standard Watts bath.

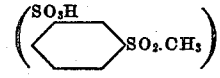
Table I

	Conc. g./l.
Diphenyl sulfone-3-sulfonic acid	1–5
	
Diphenyl sulfone-3,3'-disulfonic acid	1–5
	
1,1'-dinaphthyl sulfone-5,5'-disulfonic acid	1–3
	
2,2'-dinaphthyl sulfone-7,7'-disulfonic acid	1–3

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The above are preferred examples of the sulfonic derivatives of aryl sulfones, though other examples can be used such as the sulfonated derivatives of phenyl p-tolyl sulfone, ditolyl sulfone 3-sulfonic acid, benzene 3-sulfonic acid methyl sulfone



and others. The di-diphenyl sulfone sulfonic acids and the alkyl substituted derivatives in general are not very soluble in the presence of high concentrations of salts in the bath and though useful are not preferred examples. Preferably the sulfonated aryl sulfones should not have an —NH_2 or an —NO_2 or an —OH group attached to the aryl ring.

The best examples are the diphenyl sulfone sulfonic acids which are the simplest to prepare at the present. The sulfonated aryl sulfones can be added in the acid form or as the nickel salt or even as the sodium salt or as the salt of any other metal except a metal which produces a harmful result in the bath, e. g., a copper salt would be detrimental in the bath.

These sulfonated aryl sulfones produce excellent grain refinement in acid nickel plating baths. The plates obtained on buffed or brilliant subsurfaces are brilliant. Furthermore the nickel plating baths are made more tolerant to small percentages of foreign metallic ions such as Zn^{++}, Cd^{++}, Tl^{+}, Cu^{++}, etc. and also to organic compounds that would otherwise make the nickel plate be less ductile and less adherent.

The aryl sulfone group at least on benzene nuclei is more important than the aryl sulfonic group insofar as the beneficial effects on the nickel plate are concerned. For example, benzene sulfonic acid or meta benzene disulfonic acid or diphenyl sulfonic acid or diphenyl disulfonic acid do not produce nearly as good results as does diphenyl sulfone 3-sulfonic acid or diphenyl sulfone 3,3'-disulfonic acid. That is, the plates obtained are not as bright and they will not permit use of as high concentrations of zinc or organic substances without getting plate that is very brittle and of poor appearance.

It should be noted that there is nothing critical about the concentration of these sulfonated aryl

sulfones. If one uses less than the optimum concentration, a smaller beneficial effect will be obtained. If one uses more than the optimum concentration, even up to the saturation point, no increase in beneficial result is obtained and there are no undesirable effects.

These brightening addition agents can best be used in the acid nickel baths of the Watts type and its modifications, using formates, citrates, etc., as well as boric acid as buffers. The most suitable nickel plating baths and their temperatures and preferred hydrogen ion concentration are given in Table II. Small concentrations of citric acid especially, and also of formic, can often be used with the boric with benefit. At the higher temperatures, it is better to use the lower pH values. Nickel sulfamate can be used in concentrations up to saturation to replace the nickel sulfate, but it is not recommended in warm baths because of its hydrolysis.

Table II

$NiSO_4.7H_2O$, g./l.	$NiCl_2.6H_2O$, g./l.	H_3BO_3, g./l.	Temp., °C	pH
250–300	35–45	35–40	40–60	2.5–4.5
	200–350	35–40	40–60	2.5–4.5
200–250	75–100	35–40	40–60	2.5–4.5

This application is a continuation-in-part of my prior application Serial No. 396,854, filed June 6, 1941, which has become abandoned.

I claim:

1. The method of electrodepositing nickel which comprises electrolyzing an aqueous acid solution comprising essentially a material selected from the group consisting of nickel chloride, nickel sulfate, a mixture of nickel chloride and nickel sulfate, a mixture of nickel sulfamate and nickel chloride, and a mixture of nickel chloride, nickel sulfate and nickel sulfamate, and said solution having dissolved therein an organic compound selected from the group consisting of sulfonic acid derivatives of phenyl sulfones and sulfonic acid derivatives of naphthyl sulfones, said solution having a pH falling within a range of from 1.5 to 6.

2. The method as specified in claim 1 wherein the solution has a pH falling within a range of from 1.5 to 6 and the concentration of the sulfonated aryl sulfone falls within a range of from 1 gram per liter to 5 grams per liter of solution.

3. A nickel plating bath comprising an aqueous acid solution comprising essentially a material selected from the group consisting of nickel chloride, nickel sulfate, a mixture of nickel chloride and nickel sulfate, a mixture of nickel sulfamate and nickel chloride, and a mixture of nickel chloride, nickel sulfate and nickel sulfamate, and said solution having dissolved therein an organic compound selected from the group consisting of sulfonic acid derivatives of phenyl sulfones and sulfonic acid derivatives of naphthyl sulfones, said solution having a pH falling within a range of from 1.5 to 6.

4. The bath as specified in claim 3 having a pH falling within a range of from 1.5 to 6 and wherein the sulfonated aryl sulfone has a concentration falling within a range of from 1 gram per liter to 5 grams per liter.

5. A bath for electrodepositing ductile bright nickel plate comprising an aqueous acid nickel solution comprising essentially a material selected from the group consisting of nickel sulfate, nickel chloride, a mixture of nickel sulfate and nickel chloride, a mixture of nickel sulfamate and nickel chloride, and a mixture of nickel chloride, nickel sulfate and nickel sulfamate, and said solution having dissolved therein diphenyl sulfone 3-sulfonic acid, said solution having a pH falling within a range of frome 1.5 to 6.

6. A bath for electrodepositing ductile bright nickel plate comprising an aqueous acid nickel solution comprising essentially a material selected from the group consisting of nickel sulfate, nickel chloride, a mixture of nickel sulfate and nickel chloride, a mixture of nickel sulfamate and nickel chloride, and a mixture of nickel chloride, nickel sulfate and nickel sulfamate, and said solution having dissolved therein diphenyl sulfone 3,3'-disulfonic acid, said solution having a pH falling within a range of from 1.5 to 6.

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