

Effect of brightening additives on phosphorus content in Ni–P coatings

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Electrodeposited Ni–P coatings are well known by its improved properties. It's also known that phosphorus content in these coatings have great effect on their structure and properties. Commonly composition of Ni–P coatings can be regulated by varying phosphorus source concentration (NaH_2PO_2 or H_3PO_3) or parameters of process. Recently saccharin presence in electrolyte was shown to reduce phosphorus content in Ni–P coatings greatly [1]. But an explanation of this phenomenon hasn't given yet. Two ways of saccharin effect can be proposed. Saccharine is a brightener of the first class as it increases polarization of nickel ions reduction slightly. Adsorption of saccharin molecules on the surface of Ni–P electrode can reduce the number of active sites on which phosphorus species reduction can occur. On the other hand, the reduction of saccharin leads to the sulfur atoms incorporation into a deposit. Such sulfur containing coatings have lower catalytic ability in hydrogenation reactions as compared with pure nickel that should decrease intensity of phosphorus species reduction. There were three different additives tested to examine these assumptions. Parasulfamidobenzoic acid (PSBA) also acts as brightener of the first class but doesn't lead to sulfur incorporation to deposit. 2-Butin-1,4-diol is the brightener of the second class and increases polarization of nickel deposition greatly because of strong adsorption to nickel surface. Thiourea also acts as a brightener of the second class but additionally provides an incorporation of large amount of sulfur to coating. As can be seen from Table PSBA doesn't have any effect on phosphorus content in Ni–P coating. 2-Butin-1,4-diol can't be used in 0.005M concentration because it almost stops deposition process and only hydrogen evolution reaction occurs. When 0.0005 M concentration used, deposition process can occur and P content in coating slightly is decreased. The presence of 0.005M of thiourea in electrolyte inhibit phosphorus incorporation process and leads only to deposition of Ni–S coating (5 at. % of S).

Table. Effect of brightening additives on the phosphorus content in Ni–P coatings

Additive	–	Saccharin	PSBA	2-Butin-1,4-diol	Thiourea
$c(\text{additive}), \text{mol/dm}^3$	–	0.005	0.005	0.0005	0.005
$\chi(\text{P}), \text{at. \%}$	21.3	6.1	21.0	16.7	0.1

Thus, it becomes clear that only sulfur presence in the coating has strong effect on phosphorus incorporation to the nickel coating.

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References

- [1] A.A. Boyarintseva, T.E. Tsupak. *Electroplat & Surf. Treat.* (2017) 25: 36