

## ELECTROFORMING OF NICKEL-TIN-ZINC ALLOY

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In recent years the technology of electroforming has gained considerable importance in automobile, aircraft, radio, glass, plastics printing, defence, space and electronic fields. Copper and nickel electroforming processes are used conventionally for various applications. Apart from them silver, gold and nickel-cobalt alloy electroforming are used only on a limited scale. However, many times these electroforming processes are characterized by poor mechanical properties for highly stressed or high temperature applications. This search for high strength components resulted in the development of alloy electroforming. In this study electroforming of nickel-tin-zinc alloy has been carried out and the results are presented.

**Keywords:** Electroforming, nickel-tin-zinc alloys

### INTRODUCTION

The electrodeposition of alloys was invented at about the same time as the electrodeposition of pure metals. However, industrial electrodeposition of alloys was mainly developed during the last thirty or forty years. For this reason the electrodeposition of alloy is sometimes called "an old art and a new science" [1]. Electrodeposited alloys often have many valuable properties such as high corrosion resistance, high hardness, good antifricition properties, valuable magnetic properties, nice appearance etc [2-4]. The following alloys are at present being deposited in addition to brass and bronze, lead-tin, nickel-cobalt, iron-nickel, tin-zinc, tin-cadmium, tin-nickel [5,6], zinc-nickel, zinc-cobalt, copper-nickel [7], nickel-tungsten [8] and many others.

Copper and nickel electroforming processes are used conventionally for various applications. Apart from them silver, gold and nickel-cobalt alloy electroforming are used only on a limited scale. However, the tin-nickel alloy produced from the chloride-fluoride bath is semi glossy in appearance, hardness of the alloy is nearer to chromium, easily solderable free from stress which can replaces the conventional nickel-chromium coatings in many applications. The alloy has a limited impact resistance. Hence further research in the use of organic or inorganic addition agents to obtain bright and ductile electroform deposits. In this study

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### EXPERIMENTAL

Hull Cell experiments were carried out using the nickel-tin alloy bath having the following composition containing various amount of zinc chloride.

Nickel chloride 300 g/l, Stannous chloride 50 g/l, Ammonium fluoride 55 g/l, Ammonia to adjust the pH 2 to 2.5, Zinc chloride 5 to 50 g/l.

A 267 ml Hull Cell was used with high purity nickel anode and brass plate as cathode. The effect of addition agents like 1,2,3 benzotriazole and thiourea to the above bath containing 50 g/l zinc chloride was studied.

Current efficiency experiments were carried out on stainless steel panels at various cathode current densities 1,2,4,6 and 8 A/dm<sup>2</sup>. Throwing power of the bath at various current densities 1,2 and 4 A/dm<sup>2</sup> was also studied. The percentage throwing power was calculated using the fields formula

$$\% \text{ Throwing power} = \frac{[L - M] 100}{L + M - 2}$$

where L = Linear ratio and M = Metal ratio

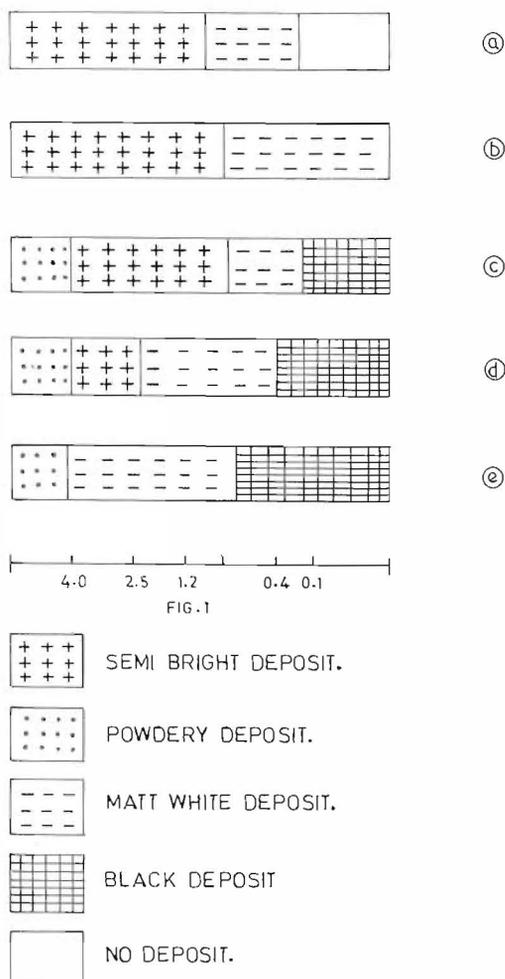


Fig. 1: Effect of zinc chloride configuration in the nickel-tin alloy bath on hull cell pattern (a) Plain bath (b) 5 g/l zinc chloride (c) 20 g/l zinc chloride (d) 30 g/l zinc chloride and (e) 50 g/l zinc chloride

RESULTS AND DISCUSSION

Effect of zinc chloride addition to nickel-tin alloy bath

The effect of zinc chloride addition on the Hull Cell pattern of the nickel-tin alloy bath is shown in Fig. 1. It is observed from the Fig. 1b, the addition of 5 g/l zinc chloride to the plating bath results in the production of matt white at low current density regions which is due to the incorporation of zinc in the deposit.

As the zinc chloride concentration is increased from 5 g/l to 50 g/l, the matt white and black nature of deposit is shifted to the higher current density region which is due to the incorporation of higher zinc content in the deposit.

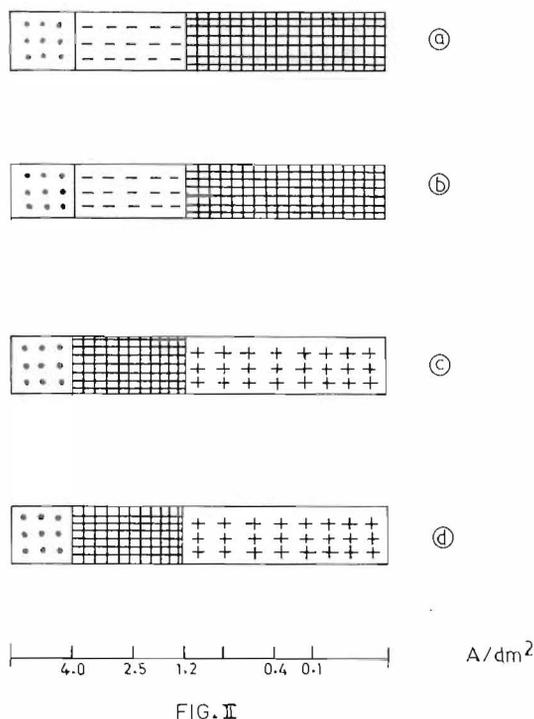


Fig. 2: Effect of addition agents on the hull cell pattern in the nickel-tin-zinc alloy bath (a) Plain bath (b) 1 g/l benzotriazole (c) 1 g/l thiourea and (d) 2 g/l thiourea

The addition agent effect

The modification of the Hull Cell pattern by incorporation of 1,2,3-benzotriazole and thiourea to the alloy electroforming bath containing 50 g/l zinc chloride is shown in Fig. 2. The addition of benzotriazole to the bath does not change the Hull Cell pattern where as the addition of 1 g/l thiourea (Fig. 2c) changes the black nature to semibright deposit in the lower current density region. Further increase of thiourea to 2 g/l (Fig. 2d) does not alter the Hull Cell pattern. Hence the bath containing 1 g/l thiourea was chosen for further studies.

Current efficiency

Table I gives the influence of current density on cathode current efficiency. It is observed that the alloy efficiency first increased from 55.77% to 82.18% with increase of current density. Due to the formation of powdery deposit the percentage of current efficiency decreased above 4 A/dm<sup>2</sup>.

Throwing power

The throwing power of the bath at various current densities is shown in Table II. The throwing power of the bath slightly

TABLE I: Influence of current density on cathode current efficiency for the electrolyte

Cathode current density A/dm <sup>2</sup>	% alloy efficiency
1	55.77
2	64.49
4	82.18
6	59.08
8	34.74

TABLE II: Influence of current density on throwing power for the electrolyte

Cathode current density A/dm <sup>2</sup>	% throwing power
1	50.01
2	48.91
4	48.95

decreased from 50% to 48.45% as the current density was increased from 1 A/dm<sup>2</sup> to 4 A/dm<sup>2</sup>.

### CONCLUSIONS

In the present study nickel-tin alloy deposition was modified by the addition of zinc chloride to obtain ternary alloys of nickel-tin-zinc. The characteristics of the electrolyte has been studied using Hull Cell. Current efficiency and throwing power studies were carried out to obtain good deposits for electroforming applications. Further work is in progress to characterize the deposit with respect to the properties to the deposit for electroforming applications.

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