

Electroforming of nickel moulds and dies for making glass reflectors

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In this article, the electroforming of nickel mould and die required for the production of glass reflectors is described with special emphasis on experience with various mandrels, characteristics of nickel electrolyte and the bath composition used to back the nickel electroform.

Key words: Electroforming, nickel moulds and dies, reflector

INTRODUCTION

Electroforming plays a key role in the production of moulds and dies used for the production of complex shaped plastics, zinc and glass materials. The specific advantages of electroforming over mechanical means for the production of metal optics is reported [1]. An interesting account of an attempt of making mould for plastic lens is reported [2]. Wasserman and Lester [3] described the production of electroformed nickel moulds from a machined fresnel master. An American patent disclosed the details on the preparation of mandrels and the production of glass pressing nickel tools [4]. Production of dies for zinc alloy die castings, plastic injection mouldings and heat exchanger blocks for food industries using Ni-SiC dispersion coatings has been studied [5]. Iten [6] gave an account of electroforming solution with minimum corner weakness.

In this paper, the authors report on the electroforming of nickel dies used for moulding glass reflectors used in various transport vehicles. The preparation of electrolyte, mandrel, properties of the electrolyte and the backing of the nickel die are briefly discussed.

EXPERIMENTAL

Mandrel preparation

The design of the mandrel corresponds to that of the headlight lens used in automobiles. The internal projections on the inside of the lens, intended for multiple reflection, that are a bit difficult to be formed by ordinary machining, have been electroformed. The glass was degreased with trichloro ethylene, cleaned with vim powder, and rinsed with running water. It was sensitized and activated in a colloidal catalyst [7] and plated with electroless nickel at room temperature for 30 minutes [8] and then nickel electroforming was carried out in the

following solution:

Nickel sulphamate	240	gl ⁻¹
Nickel chloride	15	gl ⁻¹
Boric acid	40	gl ⁻¹
pH	3.8-4.2	

Preparation of the nickel sulphamate electrolyte

The electrolyte was prepared with laboratory grade reagents. Sulphamic acid was added to a slurry of nickel carbonate kept agitated at 308-313K. Air agitation was continued for an hour to get clear solution to which nickel chloride was added. To oxidise any iron present in the bath, potassium permanganate (1 g/l) was added and the solution was heated to 323K and the pH was increased to 5.5 using a slurry of nickel carbonate and air agitated for about 6 hours and allowed to settle overnight. The solution was decanted, treated with activated charcoal (3 g/l) at 333K for six hours and then filtered. The pH was reduced to 3.8 with the desired amount of boric acid and sulphamic acid (10%) and dummied at 0.5 A.dm⁻² for 48 hours and then at 1 A.dm⁻² for 24 hours, again charcoal treated and filtered.

Bath characteristics

The electrolyte was studied for its useful current density range, using Hull cell, and current efficiency [9] measurements were also made. The hardness was tested with LECO microhardness tester supplied by M/s LECO Corporation U.S.A. at 200g load. The stress in the bath was measured with a fabricated Brenner and Sendroff's contractometer [10].

Electroforming of nickel mould and die

The mandrel was initially plated in nickel sulphamate bath at 0.1 A.dm⁻² for about 15 minutes and then the current was slowly increased and the plating was carried

at 2 A.dm^{-2} for about 15 days. Current interruption was avoided with a battery back up. The nickel was backed with a high throw acid copper solution to a thickness of 10 mm [11] and then the mandrel was broken to separate the electroform.

RESULTS AND DISCUSSION

Properties

From Hull cell data (at 2A current for 5 minutes) the useful current density was fixed at $1\text{--}3.5 \text{ A.dm}^{-2}$. The mandrel was plated at 2 A.dm^{-2} to avoid any nodulation. The current efficiency was found to be 99.0%, 98.7% and 98.5% at 1 A.dm^{-2} , 1.5 A.dm^{-2} and 2 A.dm^{-2} respectively. The stress in the bath was 7.29 N mm^{-2} and the hardness of the deposit was 381 kg.mm^{-2} at 200g load.

Experiences during mandrel fabrication

The glass mandrel could not be conductivised by spray silvering as the silver film does not adhere to it. Again, use of low melting alloys is not suitable for sulphamate electrolyte. Hence, electroless technique was chosen.

CONCLUSION

A practical approach is given to electroform mould and die using nickel sulphamate electrolyte at room temperature.

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