Photo Chemical Machining

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Abstract- The goals of the design process are usually manifold. Clearly the resulting system must satisfy its functional requirements, and will normally also have to fulfill certain non-functional requirements which might include such factors as: size; weight; cost and power consumption. When the operation of a system has implications for safety, the system will also have a set of safety requirements. These will define what the system must and must not do in order to ensure the safety of the system. These safety requirements sit alongside the functional requirements to define what the system developer must achieve. The ability of a system to satisfy both its functional and its safety requirements is limited by the presence of faults within the system. Although definitions of this term vary, here the term 'fault' is taken to mean any kind of defect within the system.

Keywords-*Electrochemical machine,photographic,Ethicing*

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I. INTRODUCTION

Nowadays, two kinds of machining exist. On the one hand, conventional machining usually employs hard material to cut a soft material such as in grinding, lapping or turning. Conventional machining processes are used in the lathe (the work piece rotates against the cutter) and in the milling machine (the cutting tool rotates against the work piece). However, some materials are exceptionally difficult to machine conventionally due to their high hardness. Indeed, the harder the work piece, the more difficult and the more expensive is the conventional machining. On the other hand nonconventional machining processes exist, including Photochemical Machining (also known as photochemical milling or photo etching), Electrochemical Machining (ECM), Electro discharge Machining (EDM) (also known as Spark Erosion) and LASER Beam Machining (LBM). All the latter processes are independent of material hardness. Indeed, in PCM, material is removed by chemical etching and therefore no stress is involved; it is the force of the chemistry which is used in PCM. Compared to conventional machining, the properties of the work piece itself are kept during the machining process. For instance, grinding involves a change of microstructure and therefore the mechanical properties decreases, leading to a more brittle metal.

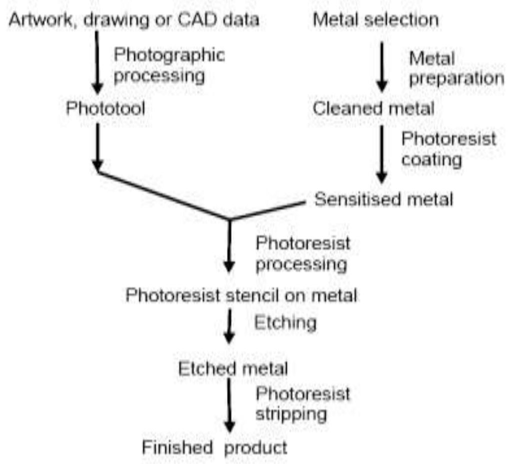

Fig 1.Steps Involved in PCM Process

Today, the photochemical machining process is especially used to produce thin, complex, 2-D parts because it is one of the few processes where the complexity of the products is not taken into account in the part cost and in the delivery time. That makes the photochemical machining process a fast, efficient, cost competitive method of producing metal components with complex designs unmatched by any other conventional metal-forming process. Another advantage of the process is the possibility to etch a wide range of materials such as metals, glasses or ceramics. However, the easiest metals to etch are copper, zinc, steels, magnesium, aluminum, nickel and Kovar (Fe, Ni, Co). Due to the diversity of materials used in the photochemical machining process, a wide range of applications can be found in various areas, such as electronics, automotive, aerospace, medical, optics and other engineering industries.

II. LITERATURE REVIEW

Oxygen-free high thermal conductivity (OFHC) copper is generally utilized as a part of cryogenics OFHC is created by the immediate change of chose refined cathodes and castings under deliberately controlled conditions to avoid sullying of the immaculate sans oxygen metal amid preparing. The technique for delivering OFHC copper protects additional high review of metal with a copper substance of 99.99%. With so little a substance of superfluous components, the natural properties of essential copper are delivered to a high degree. Qualities are high malleability, high electrical, warm conductivity high effect quality, great wet blanket resistance, simplicity of welding, and low relative unpredictability under high vacuum. Numerous links today are promoted as utilizing "oxygen free copper," copper which has been tempered in a without oxygen environment. OFC is prevalent in sound links, and has started to make advances into the video link market also.. The benefits of OFHC for such applications are, be that as it may, negligible.

A.1 Oxygen-free copper (OFC) or Oxygen-free high thermal conductivity (OFHC):-

Copper generally refers to a group of wrought high conductivity copper alloys that have been electrolytically refined to reduce the level of oxygen to 0.001% or below. Oxygen-free copper is typically specified according to the ASTM/UNS database. The UNS database includes many different compositions of high conductivity electrical copper. Of these three are widely used and two are considered oxygen-free.

A.2 Oxygen-free phosphorus-containing copper:-

Concoction scratching is the controlled disintegration of work piece material by contact with solid substance arrangement. The procedure can be connected to any material. Copper is one of the widely utilized designing material as a part of the manufacture of microelectronic segments, small scale built structures and exactness parts by utilizing substance carving process. In this study, copper is artificially carved with the etchant ferric chloride (Fecl3) at 50 °C. The impacts of chose etchant and machining conditions on the profundity of engraving, engraving rate, draw rate, undercut and surface harshness were explored. The exploratory study gave that ferric chloride created the speediest compound engraving rate. The high electrical conductivity coppers examined here above in this article are particular from coppers deoxidized by the expansion of phosphorus in the refining process. Without oxygen phosphorus-containing copper (CuOFP) is ordinarily utilized for basic and warm applications where the copper material will be liable to temperatures sufficiently high to bring about hydrogen embrittlement.

Fig 2. Application of copper OHFC

Manufacturing of a full range of OFHC Copper, annealed copper, aluminum and gold and silver plated, and elastomeric fluorocarbon gaskets for CF flanges is possible. Metal gaskets are impermeable to gases and withstand moderately high temperatures indefinitely. The CF flange is the most widely used for high vacuum and UHV applications. Many gauges, instruments, accessories are available on this flange system

B.SELECTION OF MATERIAL

Metals ought to have grain size as fine as could reasonably be expected, in light of the fact that the smoothness of edges of the parts diminishes with expansion in grain size. A metal that is dissolvable in etchant ought to be picked. A material ought to be level and of uniform thickness. Surface completion ought to be uniform and it ought to be free from scratches, implanted particles or considerations. As of now in industry there is part of work must be done on OFHC copper in view of use range of OFHC copper is higher in mechanical and also in business. So there is necessity of determination of best process parameter for good results (carve rate, scratch rate, surface completion, undercut,). From writing audit it is seen that there is no standard writing accessible on Oxygen Free High Conductivity Copper.

III. PHOTOCHEMICAL MACHINING PROCESS

Photo chemical machining process is an engineering production technique for manufacture of burr free and stress free flat metal component by selective chemical etching through photochemical production mask. Also known as photo etching, it removes material by chemical dissolution, creating new parts from a thin material. It should be noticed that no mechanical cutting is needed. Basically, PCM consists of thin metal with a photo resist. After producing the photo tool (giving the shape of the part), the specimen is inserted between

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the double-sided photo tools. This sandwich is then exposed to UV light on both sides. Thus, some parts of the photo resist will have reacted and polymerized whereas the remainder will be removed during the development process. Then, as some metal areas are not coated any more by the photo resist, the etchant solution can attack the metallic surfaces, and dissolve them. Machining consists of removing material from the bulk in order to obtain the shape required. Photochemical machining (PCM) is a non-conventional machining process. Also known as photo etching, it removes material by chemical dissolution, creating new parts from a thin material. It should be noticed that no mechanical cutting is needed. Basically, PCM consists of sensitizing the thin metal with a photo resist. After producing he photo tool (giving the shape of the part), the photo-sensitized metal is inserted between he double-sided photo tool. This sandwich is then exposed to UV light on both sides. Thus, some parts of the photoresist will have reacted and polymerized whereas the remainder will be removed during the development process. Then, as some metal areas are not coated any more by the photoresist, the etchant solution can attack the metallic surfaces, and dissolve them. The quality of the metal used for the process is always purchased as photo etching quality; it has a superior surface finish to standard commercial grades. The metal is cold rolled, high precision, especially in relation to the thickness tolerances of gauge.

IV. PROCESS

The photochemical machining process can be divided into four main stages the photo tool manufacturing, the cleaned metal part coated with the photo resist, the photo resist processing and the etching process. The photo tool manufacturing and the photo resist coating can be carried out at the same time.

A. PHOTO TOOL MANUFACTURING

The artwork generation step is usually done in a 2D CAD file. This artwork is downloaded to a laser imager that exposes the desired image on photographic film. This exposed film s then developed. Thus, film areas exposed by the laser imager become opaque to U.V.light whereas unexposed areas become transparent. Basically, a photo tool is a clear polyester sheet with black lines and therefore contains the Master Image Pattern. This photo tool allows transference of this image on the photoresist but this process will be discussed later on. Indeed, in PCM, a registered, double-sided photo tool is usually manufactured as etching is usually carried out on both sides of the metal foil simultaneously in order to reduce undercutting phenomenon .Photo tools allow fine details to be obtained and the shape of the part can be changed very easily.

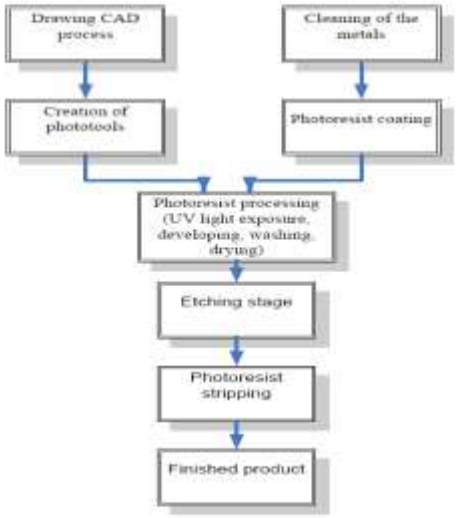

Fig 3. Summary of the etching process.

B.PHOTO RESIST COAT:

The first part of this stage is to clean the metal surfaces prior to having the photo resist applied. The cleaning operation aims to remove any substance which is at the surface of the metal. Indeed, oil or grease could prevent good adhesion of the photo resist on the metallic surfaces. Two main methods are considered in industry. The first one is mechanical; it consists in scrubbing the metal sheet on which slurry is sprayed. Basically, slurry is formed of a mixture of abrasives with water. The limitation of this method is the metal thickness because good results are not achieved with very thin gauge metal. Photo resists are liquid photopolymers which have their chemical structures altered by exposure to UV light. Two kinds of photo resist exist: positive-working resists and negative-working resists. Basically negative resists harden and strengthen during UV exposure and positive resists degrade during UV exposure.

C.PHOTO RESIST PROCESSING:

Before being exposed to the UV light, the substrate coating looks like a sandwich as shown in Figure 2.11. It can be noticed that there is no polyester layer because Figure 2.11 represents a liquid resist coating. In the case of a dry film photo resist coating, a polyester layer would be between the negative-working photo resist and the photo tool. Bowed metal has to be avoided during exposure because misalignment occurs on double-sided exposures. Thus, a vacuum is used. It evacuates air from the exposure frame, forcing the photo tool into intimate contact with the resist during exposure, preventing off contact printing and enhancing fine line reproducibility. Once the whole assembly is in contact (by vacuum), it is exposed to UV light. By considering a negative working resist, the photo resist will harden where the photo tool areas are transparent whereas the unhardened photo resist (i.e. areas which were protected by the photo tool) is then washed away by using an aqueous solution.

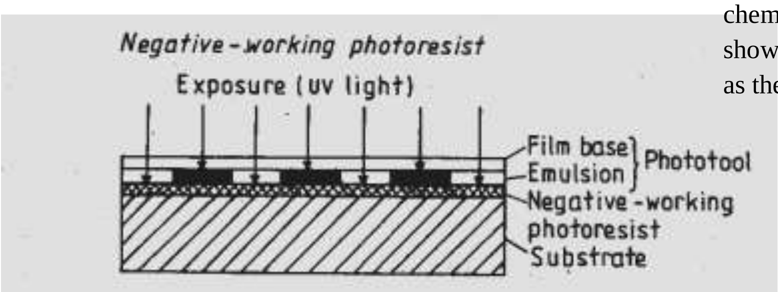

Fig 4. Substrate coating before light exposure

It can be noticed that the exposure time can vary. For instance, increasing exposure time allows for fine line resolution whereas decreasing exposure time allows for fine space resolution. Thus, a balance has to be made between fine line resolution and fine space resolution. Then, the protective film (polyethylene terephthalate) has to be removed if a dry photo resist is used. The next step is to remove the unexposed photo resist from the material (development process). This consists in spraying the exposed material with sodium carbonate based solution. However, care is needed if very fine lines are present on the photo tool. In this case, it may be possible that undeveloped photo resist is on the metallic lines which have to be etched later on, leading to an unsatisfactory etch quality and an inaccurate component. Moreover, it is advisable to bake the remaining photo resist (stencil) in order to make it tougher. This solution is especially advantageous in deep etching applications.

D.ETHICING:

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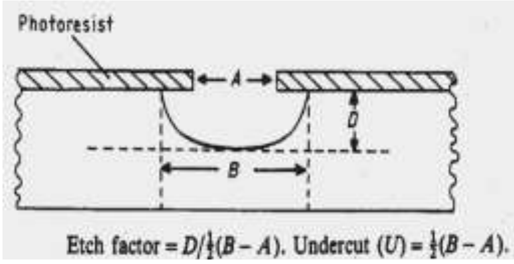

Fig 5. Expression for the etch rate.

Once the work piece has been etched, the last step is to remove the photoresist by using a chemical solution in which the stencil dissolves.

V. CONCLUSION

This work was carried out to study the viability of PCM process on OFHC copper foil material by using Ferric Chloride etchant.

1. The measure of performances is undercut, surface roughness and etch rate. An optimal parameters combination for the maximum etch rate, minimum undercut and surface roughness within the range of selected control parameters are obtained by using Analysis of Variance (ANOVA), F-test and Grey Relational Analysis (GRA holds good).
2. It is observed from the results that, 93% of experiments shows OFHC copper is having better surface roughness (ranging from 0.54 to 3.46μm), hence it is found that the surface roughness increases with increase in temperature.
3. It is observed that Grey Relational Analysis results states the optimal PCM process performances for surface roughness, undercut and etch factor are obtained at etchant temperature (50°C) Level 2, Concentration of etchant (800 gm/lit) Level 3 and Time of etching (15 min.) Level 1 are the most significant Input parameters.
4. It is observed from the results that, undercut varies from 0.0100 mm to 0.2180 mm, where as the etch rate varies from 0.00784 to 0.01173.
5. The above discussion confirms the validity of G.R.A. methodology for enhancing the etching performance and optimizing the etching parameters. The etch factor, surface roughness value and undercut are greatly improved by this approach.
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VI. FUTURESCOPE

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