QUANTATIVE ANALYSIS OF UNDERCUT IN PCM FOR SS304

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Abstract – *This paper deals with the experimental investigation of optimum values of process parameters in PCM to improve the productivity and also to improve the surface quality. Problem has been formulated in undercut in order to increase the productivity and minimization of Ra. Taguchi orthogonal array method is used for Design of experiment. Optimum values of process parameters are obtained using Undercut, etchant concentration, time and temp. It is observed that the undercut increases for the optimum values maintaining the surface quality.*

Key Words: PCM, optimization, process parameters, orthogonal array method, undercut, surface roughness(Ra),etc

1. Introduction

Photo chemical machining is an engineering production technique for the manufacture of burr free and stress free and stress free flat metal components by selective chemical etching through a photographically produced mask. 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 thin metal with a photo resist. After producing the photo tool (giving the shape of the part), the workpiece is inserted between 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.

2. Experimental Setup

Fig.1 Photo tool **Fig.2** UV exposure **Fig.3** Etchent Machine Preparation

During experimentation; temperature, the time of etching and concentration of etchant is necessarily to be changed. For this heating bath is used which varies temperature from 20° C to125°C. In this heating bath heater is used to change the temperature of water which can be sensed by sensor. In this heated water, four beakers can be placed for experimentation. This instrument is used in placing of etching machine as shown in Figures below.

Fig.4. Nikon Measuring Microscope

3. Design of Experiment

Design of experiments (DOE) refers to planning, desingning and analyzing an experiment so that valid and objective conclusion can be drawn effectively and efficiently. In performing a designed experiment, changes are made to the input variables and the corresponding changes in the output variables are observed. The input variables are called resources and the output variables are called response.
Input variables: Time, Temperature and Concentration of etchant.

Output variables: Undercut, Etch rate, Surface Roughness

4. Taguchi Orthogonal Array Method

Taguchi Orthogonal Array (OA) design is a type of general fractional factorial design. It is a highly fractional orthogonal design that is based on a design matrix proposed by Dr. Genichi Taguchi and allows you to consider a selected subset of combinations of multiple factors at multiple levels. Taguchi Orthogonal arrays are balanced to ensure that all levels of all factors are considered equally. For this reason, the factors can be evaluated independently of each other despite the fractionality of the design.

5. Experimental Result

Table 1. Experimental Results

T.C.	Temperature(^{0}C)	Concentration(gm/liter)	Time (minute)	Undercut (mm)
1	55	500	10	0.00135
2	60	500	6	0.00590
3	60	500	8	0.04580
4	60	500	10	0.00105
5	60	600	6	0.00350
6	60	600	8	0.01645
7	60	600	10	0.00780
8	60	700	10	0.02095
9	65	500	6	0.03200
10	65	500	8	0.00340
11	65	500	10	0.00405
12	65	500	12	0.00600
13	65	500	14	0.00145
14	65	550	10	0.00135
15	65	600	6	0.00130
16	65	600	8	0.00050
17	65	600	10	0.00315
18	65	650	10	0.00500
19	65	700	6	0.00140
20	65	700	8	0.00265
21	65	700	10	0.00670
22	70	500	6	0.00075
23	70	500	8	0.00085
24	70	500	10	0.00135
25	70	600	6	0.00080
26	70	600	8	0.00135
27	70	600	10	0.00505

6. Analysis of Variance (ANOVA) Method

Analysis of Variance (ANOVA) is a statistically based objective decision making tool for detecting any difference in average performance of groups of items tested. The decision rather than pure judgments, take variation in to account. The experimental design and subsequent analysis like ANOVA are intrinsically tied to each other. Analysis of Variance (ANOVA) breaks total variation down into accountable source and total variations is decomposed into its appropriate components.

7. Interaction Plot for Undercut

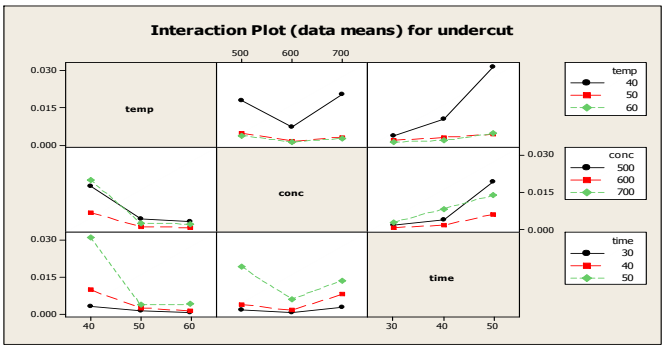

Fig.5 Interaction plot by MINITAB

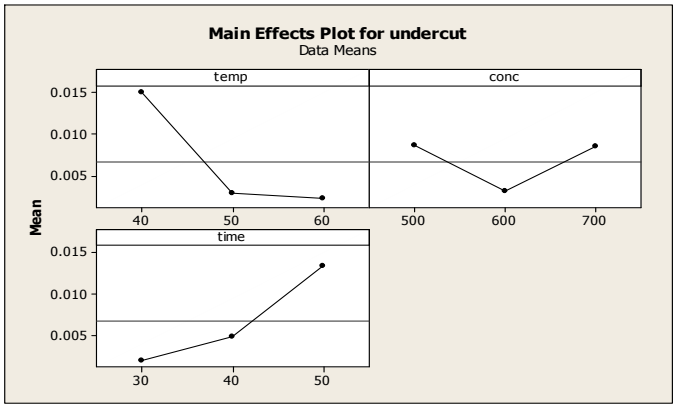

Fig.6 Main effect plot for Undercut in MINITAB

8. Artificial Neural Network (ANN)

A neural network is an adaptable system that can learn relationships through repeated presentation of data and is capable of generalizing to new, previously unseen data. Some networks are supervised, in that a human determines what the network should learn from the data. In this case, you give the network a set of inputs and corresponding desired outputs, and the network tries to learn the input-output relationship by adapting its free parameters. Other networks are unsupervised, in that the way they organize information is hard-coded into their architecture

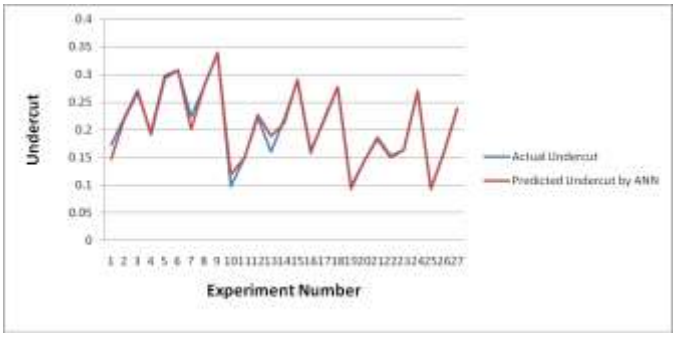

Fig. 7 Comparison of actual and predicted values of undercut of SS304

9. Conclusion

In the present work an attempt has been made to study the effect of PCM process parameter on stainless steel 304 by using ferric chloride as etchant. Etching is carried out under same time and at same environment condition by dipping the work piece at a time in chemical. The process parameters used are temperature, concentration and time. The undercut and surface roughness measure by the Nikon measuring microscope. The ANOVA result for ss304 shows that optimal PCM process performances for the undercut are obtained at etchant temperature (50°C) Level 2, Concentration of Etchant (600 gm/lit) Level 2 and Time of etching (40 min) Level 2.

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