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PULSE ANODISING USING MICROPROCESSOR CONTROLLED PULSE UNIT

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ABSTRACT

The influence of 'on' and 'off' times and the frequencies of pulses on the anodised film using conventional sulphuric acid bath with the help of microprocessor unit have been studied. The properties of the oxide film with respect to hardness, coating weight and density are better, compared with conventional oxide film produced in sulphuric acid. The details on the control unit and results obtained are discussed.

Key Words: Pulse anodising, microprocessor controlled pulse unit, hard anodising

INTRODUCTION

Aluminium being a very reactive metal is always covered with a very thin oxide film of thickness ranging from 100-150°A. The film protects the metal under mild service conditions. However by subjecting the metal to anodic oxidation many desirable properties can be imparted to the metal according to the end use. Generally for decorative purposes, anodising is carried out in sulphuric acid at 20-25°C using direct current and a current density of 1.2 to 1.6 amp/dm^2 [1,2]. For engineering applications thick abrasion resistance oxide film are produced by anodising at very low temperature using higher current density [3]. Aluminium alloys which contain more than 5% Cu or 7% Si will not respond to conventional anodising processes using d.c. power source. So a.c. superimposed over d.c. [4] or pulse current generators [5] are used for hard anodizing.

To obtain uniform coating by anodising and for the accurate maintenance of optimum processing conditions microprocessors are widely used. The usage of microprocessor controlled pulse anodising unit and the advantages derived from it have been reported in a patent [6]. In this paper, the circuit details of pulse current generated from a microprocessor unit fabricated in this Institute for anodising 2S aluminium alloy in sulphuric acid electrolyte using very high current density at 20°C is described.

CIRCUIT DESCRIPTION

The layout of the circuits used in the process is shown in Fig.1.

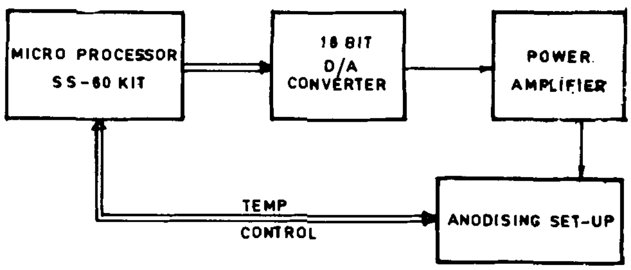

Fig. 1. Block diagram of anodising unit

The unit contains a programmable d.c. power supply unit of capacity 50 volts and 10 amps, a microprocessor unit and 16 bit D/A converter and other interfacing chips. Using software, the following functions of output could be varied: (1) type and magnitude of pulse current (2) steady state (background) d.c. current (3) period (4) number of pulses and (5) temperature of the bath. Programs to generate the waveforms shown in Fig.2. are available.

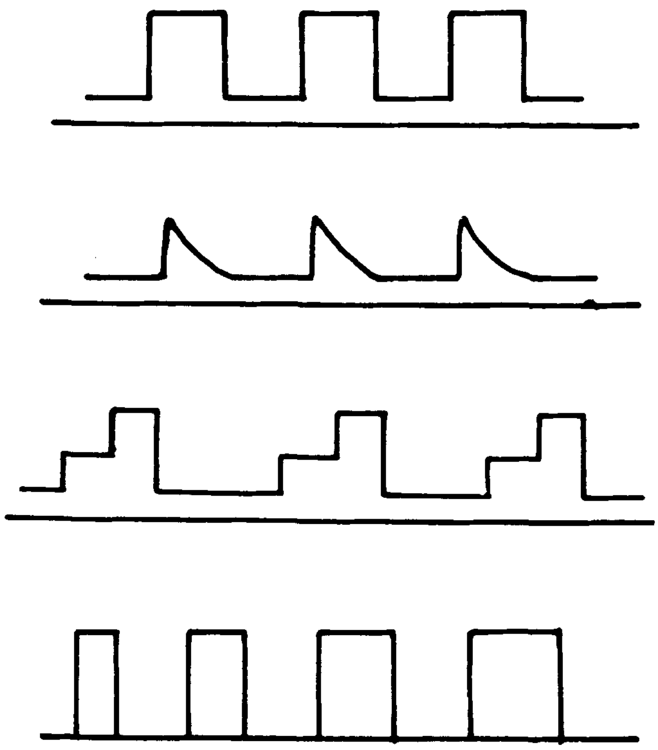

Fig. 2. Type of waveform generated (with software control on period, amplitude and type)

Using microprocessors, the controllable parameters are keyed in. Executing the unit the microprocessor gives out appropriate digital signals at the appropriate time. D/A converts the above signal to analog signal. This control wave form is fed to programmable galvanostat to get the desired current waveform. The unit can be made to work either in timer mode or in countable number of cycles mode. After anodising to the desired period of time, the unit automatically comes to a halt.

SOFTWARE DETAILS

The flow chart shown in Fig. 3 describes the sequence of operation carried out in microprocessor. Various types of waveform generations are included

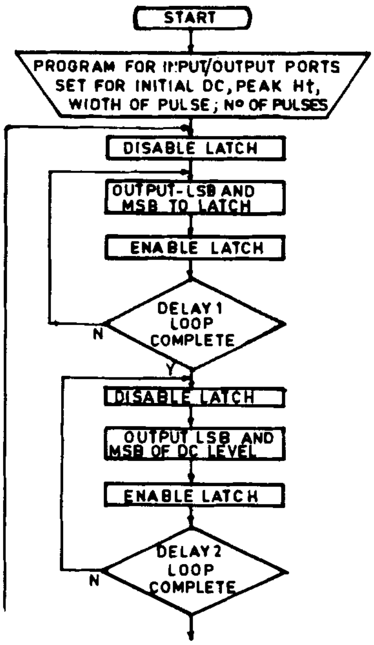

Fig. 3. (a) Flow chart to generate a pulse waveform

as subroutines. The unit was tested with a square wave with variable on and off time durations and the flow charts summarise that particular programme.

On executing, output and input parts are defined and the d.c. level current is delivered at the output terminals. Then digital signal corresponding to the pulse (1) level is delivered. The delay loop 1 sets the period of 'on' duration and at the end of it, digital signal to the pulse zero d.c. level is delivered. Delay loop 2 sets the off duration. At the end of it, one cycle is counted and the counted cycle is compared with the programmed number of cycles for continuation. Temperature signal is fed in at the end of each cycle and A.C. power device is accordingly triggered, to get the desired bath temperature. At the end of programmed number of cycles, the operation is stopped.

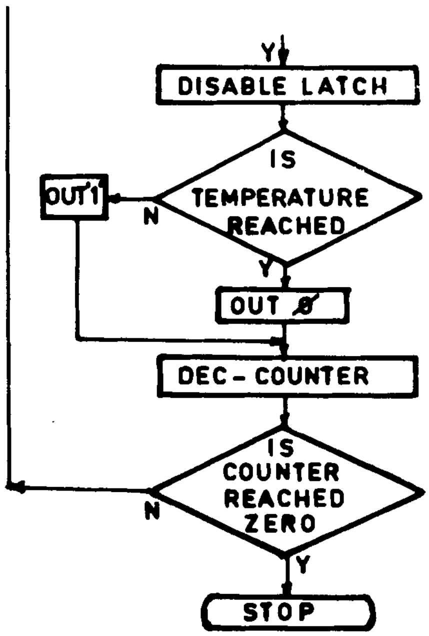

Fig.3. (b) Flow chart to generate a pulse waveform

EXPERIMENTAL

Aluminium panels of 5cm x 2.5 cm with 2 mm thickness were degreased with trichloroethylene, etched for 1 to 2 minutes in 7% NaOH solution at 40 to 45°C and then desmutted in 10% nitric acid for 1 to 2 minutes. Finally the panels were washed with distilled water. 25 litres of 165 g/l sulphuric acid bath was prepared in a PVC tank provided with lead cooling coil and perforated rigid PVC pipe for air agitation and chemically pure lead cathodes. The temperature of the bath was maintained at 20 ± 1°C by circulating glycol-water mixture at -5°C through lead cooling coils from a calora thermostat. To dissipate the heat generated during anodising, 3 c.ft. of air per minute at 1 psi pressure was used for agitating the electrolyte. The pretreated aluminium panel was immersed in the electrolyte and connected to the positive terminal, and the lead sheet to the negative terminal respectively of the programmable power supply unit. Anodising was carried out for 30 minutes using square wave pulse of different pulse repetition rate. Experiments were carried out at various current densities. To study the influence of pulse repetition rate, the duration of anodising and the total coulombs impressed were kept constant for each current density.

After anodising, the thickness of the oxide film was measured using Dermitron model 9.D. The weight of the oxide film expressed in $mg.dm^{-2}$ is determined by gravimetry by stripping it in standard chromic-phosphoric acid mixture and from the area of the plate. From the above data, density of the film was calculated.

RESULTS AND DISCUSSIONS

For the anodised specimens, the parameters such as density, weight of the oxide film and its thickness at different current densities and frequency of pulses are evaluated, to assess the quality of the oxide film. Fig.4 shows the relationship between the weight of the oxide film and the various frequencies of pulses at different current densities. It is observed that the weight

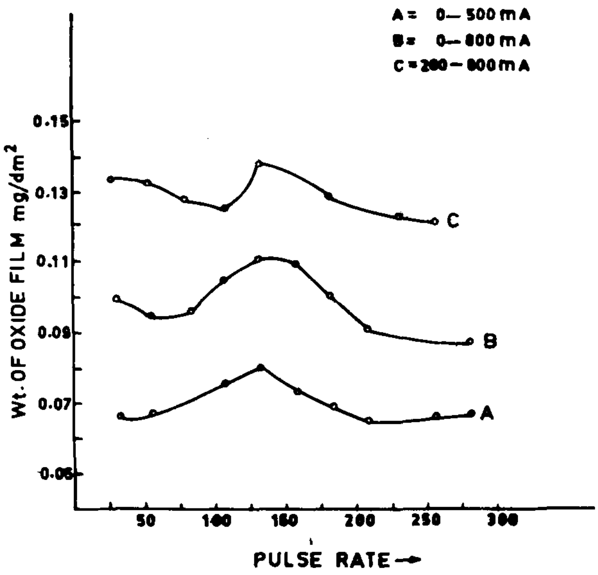

Fig. 4. Pulse rate vs wt. of oxide film

of the oxide film increases with pulse frequency and reaches a maximum at 125 Hz. Moreover, higher the current density impressed, higher will be the weight of the oxide film. If the value of the weight of oxide film is compared to the increase in current density for a particular frequency of pulses, the oxide film weight per unit area is found to increase. So also

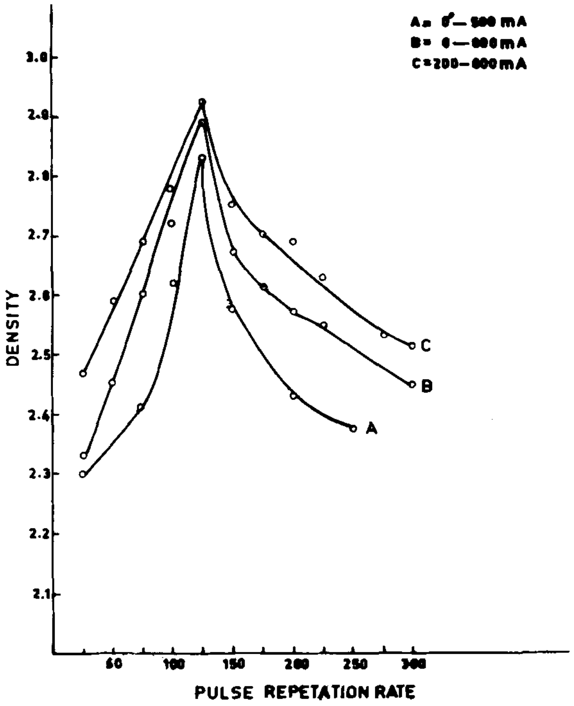

Fig. 5. Pulse repetition rate vs density

in Fig. 5 and 6, we observe that the density and thickness of the oxide film follow the same trend.

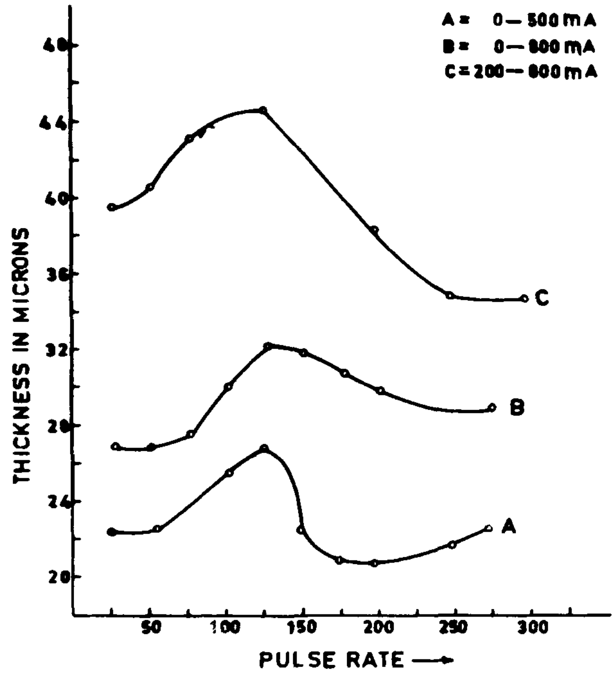

Fig. 6. Pulse rate vs thickness

The data obtained by pulse anodising are compared with the data of anodised sample using d.c. for the same duration of anodising. The results of the characteristics of the oxide film obtained at 125 pulse repetition rate is compared with anodising carried out with steady direct current and shown in Table I.

TABLE I: Comparison of the quality of the oxide film formed by pulse technique with that obtained with d.c.technique

Anodising technique	Coulombs	Weight of the oxide film mg·dm^{-2}	Density g/cc m	Thickness in micron
Pulse technique	450	643	2.83	27
	720	835	2.89	32.5
	900	1100	2.92	45
DC technique	900	959.6	2.74	35

It is clear from this Table that pulse current anodising gives better oxide film compared with the film by steady d.c. current method.

CONCLUSION

Preliminary study in pulse anodising shows a good promise in getting a certain thickness of film with less coulombs. Flexibility of microprocessor programmes enables one to evaluate the various parameters very precisely to get uniform reliable anodising.

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