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Comparison of Technology- DC Plating, Pulse Plating and Pulse Reverse Plating on Printed Circuit Board

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***Abstract*—** Printed circuit board (PCB) is the mother of any electronic system. Plating is performed on double sided PCB of size 5 x 8 cms with instrumentation amplifier. Plated material, silver serves as connecting material between various layers. Strong adhesive coating is required to overcome the wear and tear due to vibration, stress and movement between the parts. Various plating techniques are considered and the optimum plating value is identified. Pulse reverse plating has better current efficiency when compared to other techniques. With increased repeatability and decreased production cost pulse plating method is more beneficiary. For the same time period of 60ms various plating is carried out and the deposition is observed and the efficiency is high for pulse reverse plating.

***Keywords*—** *Pulse reverse plating, pulse plating, printed circuit board,silver*

I. INTRODUCTION

Plating technology is more predominant in manufacturing industry, Medical field and Jewellery industry.In manufacturing industry every movable part require plating in order to overcome wear and tear. In medical field surgical instruments make use of surgical silver and they are of high quality. Jewellery industries use plating to improve its aesthetic value. . Developments in electronics have led to the introduction of pulse wave rectifiers. Silver coating is performed by the following equation. Silver is coated using potassium cyanide solution.

$$AgCN + KCN \rightarrow KAg(CN)_2 \quad (1)$$

II. RESULTS AND DISCUSSION

DC plating

Table 1 gives the readings taken for DC plating at various current densities. Theoretical weight and Thickness are calculated from the formulae. Experimental weight is measured using weigh meter .The current efficiency is as low as 79.6 The maximum efficiency is found at the peak current density of 2.8973 and the value is 87.1.The readings are not taken above this value because it will lead to burnt deposit.

Table 1 Direct Current (Dc) Plating

Peak current (ampere)	Peak current density amp/dm^2	Theoretical weight (gms)	Theoretical Thickness (µm)	Experimental Thickness (µm)	Weight deposited Experiment (gms)	Current efficiency (percent)	Hardness VHN
1.0	1.524	0.2012	4.678	3.803	0.1601	79.6	76.9
1.3	1.9812	0.2616	6.0824	4.313	0.2098	80.2	81.2
1.6	2.438	0.3219	7.484	6.337	0.2745	85.3	82.3
1.9	2.8973	0.3823	8.888	7.526	0.3329	87.1	84.2

Table 2 Pulse plating

Average current=0.9 amps			**RPM = 50**	**Specimen area=0.41 mm^2**				
Ip=varies			**RTC = 180 sec**	**density of Silver = 10.49gm/cm3**				
Duty Cycle		**Pulse Frequency (Hz)**					**weight deposited (gms)**	**Thickness (microns)**	**J (A/dm^2)**
		10	**25**	**50**	**100**	**500**			
40%	Ton-Toff(ms)	40-60	16-24	8-12	4-6	0.8-1.2	0.181	4.211	1.707
	Vav (volt)	0.6							
	I_P (ampere)	0.7							
	WED (grams)	0.130	0.116	0.107	0.078	0.063			
	Exp. Th. (µm)	3.369	2.864	2.562	2.006	1.610			
	Efficiency %	71.8	64.08	59.1	43.1	34.8			
60%	Ton-Toff(ms)	60-40	24-16	12-8	6-4	1.2-0.8	0.181	4.211	1.463
	Vav (volt)	0.7							
	I_P (ampere)	0.6							
	Weight(grams)	0.162	0.143	0.103	0.062	0.041			
	Thickness (µm)	4.05	3.57	2.412	1.59	0.691			
	Efficiency %	89.5	79.0	56.9	34.2	22.6			
80%	Ton-Toff(ms)	80-20	32-8	16-4	2-8	1.6-0.4	0.181	4.211	1.219
	Vav (volt)	0.6							
	I_P (ampere))	0.5							
	WED (grams)	0.148	0.121	0.96	0.059	0.032			
	Exp. Th. (µm)	3.70	3.025	2.390	1.44	0.601			
	Efficiency %	81.7	66.9	53.0	32.5	17.6			

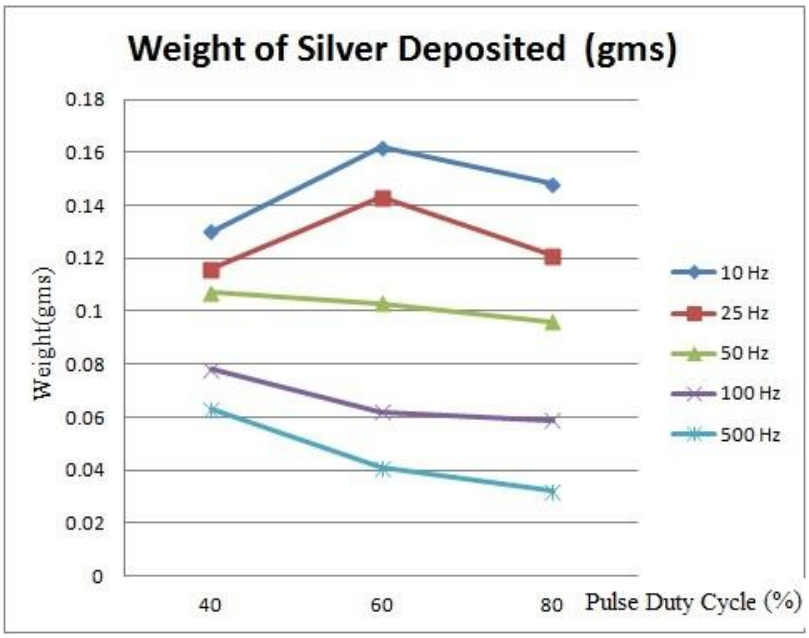

Figure 1 Variation of Weight of Silver Deposited in Grams to Pulse Duty Cycle at Current Density of 2.195 amps/dm^2

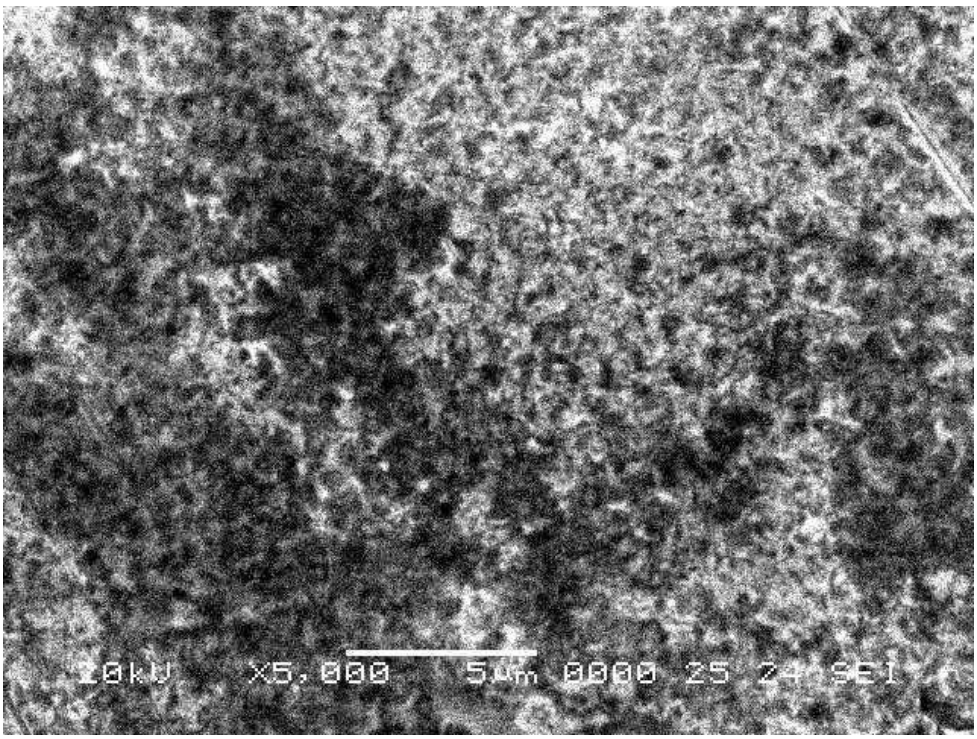

Figure 2 Scanning Electron Microscope Detail for Peak Current Density of 2.8973 and Current Efficiency 87.1%

From Figure 2 observation shows that the silver deposited on PCB is coarse grain.Since the grain is not fine it leads thickness variation from one layer to another layer. Current efficiency of DC plating is 87.1%.

PULSE REVERSAL PLATING

Pulse reversal plating has better smooth grain when compared to other deposits.The crystalline structure of coating is influenced by this method.

The pulse reverse plated specimen is tested for XRD .The sample n.o with DOE1 and DOE11, which contain the highest current efficiency are examined. The metal coated is silver and it is proved from the JCPDS N.O:87-0598.The structure of the metal deposited is hexagonal in nature.

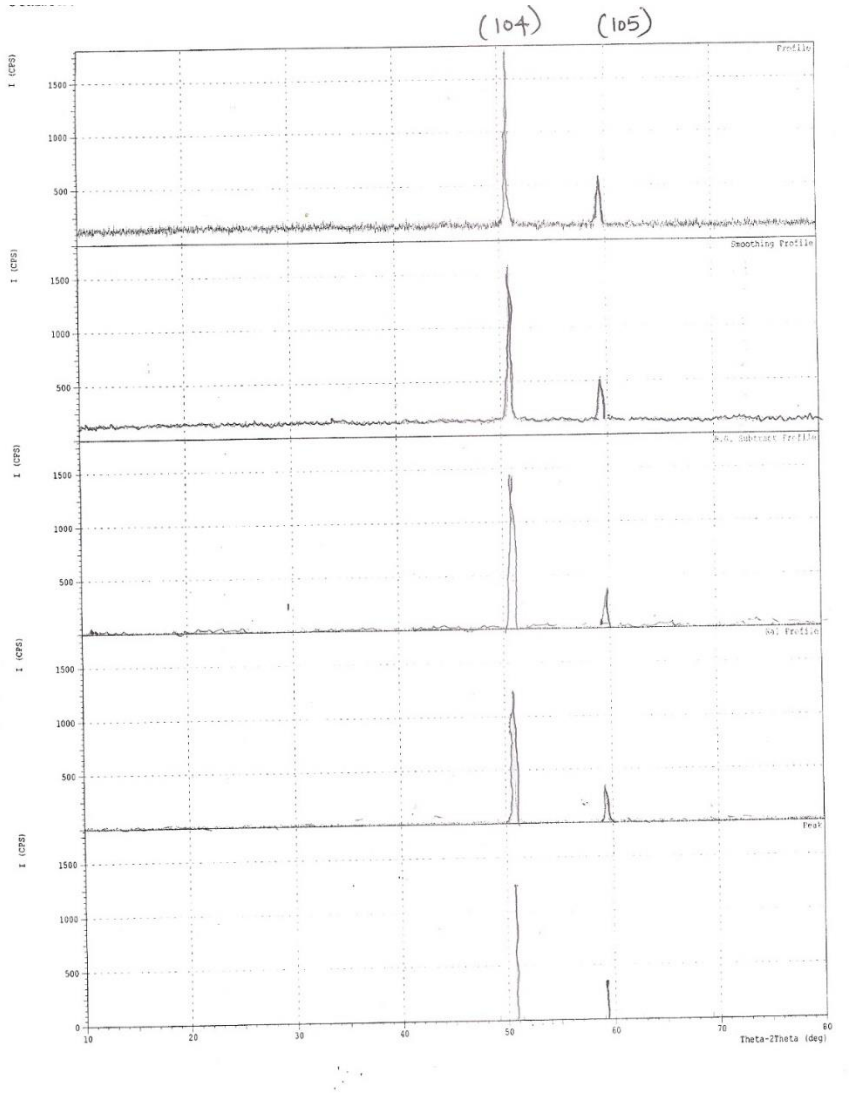

Figure 3 XRD Graph for the Specimen of DOE 1

Table 3 Strongest 2 Peaks of XRD of DOE 1

S. No.	Peak nunmber	2θ	Diffraction (A)	I/I1	Full width half max (deg)	Sharpness (counts)	Total (counts)
1	2	51.6827	2.08603	100	0.17290	300	2925
2	5	59.0600	1.81482	3	0.13000	10	116

From the scherrer calculation , the size of grain is 8 nm for DOE 1 .When the grain size is minimum it is obvious that the adhesion of silver on to the PCB is going to be high.The reverse pulse dominates the reverse action and it leads to surface uniformity. The forward and reverse cycles influence the size of silver deposited .

Table 4 Various Plating Techniques and their Corresponding Weight and Efficiency(%) for the same time period of 60 ms

S.No	PLATING technique	WEIGHT DEPOSTED (grams)	CURRENT EFFICIENCY (%)
1	DC plating	0.3329	87.1
2	PULSE plating	0.162	89.5
3	PULSE REVERSE plating	0.01496	98.3

Pulse reverse plating technique shows better efficiency

III. CONCLUSION

Time taken for plating of the PCB by pulse reversal is high and that is the only disadvantage of pulse Reverse plating. Pulse reversal is affected by the additives involved in the bath. Pulse reversal plating obtains a maximum current efficiency.So finally Pulse reverse plating is better plating technique when compared with other types of plating with respect to its grain size , efficiency and adhesion.

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