3 Dimensional Large Scale Current Distribution Analysis -Cu, Ni, and Cr Plating on Plastics-

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An electric current distribution analysis program "Electroplating Pilot System" (EPPS) was designed and developed to offer you in this industry. EPPS are used in various applicable fields of electrochemistry field in Japan, and so successful with the customers.

EPPS has installed the high performance and high-speed solver with the technology of the latest improvement of finite element method. 3 dimensional large scale analysis is available to be performed with PC, and it is possible to get the current distribution of the complicated shaped parts in the short time. EPPS can provide the current distribution analysis data for the production cost effective.

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Introduction

We have developed (Current distribution analysis program EPPS) and it has been successful to market in this industry. Lately, (3 Dimensional Large Scale Analysis) was attained by using the high speed solver of the finite element method into the analysis program, and with PC's calculation capability improvement. Furthermore, with utilizing the solid model data of CAD, mesh creation is available to be performed, and the current distribution of the complicated shaped part in the production line tank is also available to be calculated.

In order to review the analysis accuracy and reliability, the thickness distribution of the automobile parts which was plated in the production line was compared with. As the analysis report is showing us that the comparison of the thickness distribution is correspondent each other, we can be confident to offer for the practical use in the production line.

Plating test

The appearance of plating parts is shown in Fig. 1. Five (5) kind of racks were prepared and each part distance and the angle are not the same (Table 1). The parts were plated with electroless nickel plating for conductivity, and the following electrolytic copper, nickel, and chromium plating were performed under the conditions that is shown in Table 2. Since this plating procedure is for the comparison with the analysis, the parts positioning, the current value, and the plating time are not optimized. The structure of a copper plating tank and the part positioning were shown in Fig. 2 in 1/4 portion of the tank. The deposit thickness was measured by coulometric thickness tester. The contour plots of the potential, the current density, and the deposit thickness of an analysis result are shown in Fig. 4-6.

Analysis

The solid data of CAD (CATIA V4) were read into pre/post processor, and the tetrahedron elements generated the mesh data automatically. It is necessary to specify the numbers of division beforehand to be solids, surfaces, and curves. The analysis model was arranged according to the size of the plating tank of copper, nickel and chromium. The parameter of analysis used the value of each plating bath. The mesh division figure having shown in Fig. 3 is about the copper plating tank, with 798559 nodes and 4436795 elements. This analysis was arranged with PC Pentium4 2GHz and memory 2GB. For the analysis of the copper plating tank of rack No.1, the model mesh division time by pre/post processor is in 2 hours & 36 minutes. Data conversion is 6 minutes & 30 seconds, and analyses took 48 minutes & 40 seconds.

Comparison

The thickness distribution comparison of the parts is shown in Fig. 7. The measured value is from the average of three(3) values which were in the 4th step and the 5th step from the upper row of rack No.1. Eight points were measured from the center of the front at the part end to the transverse direction (Fig. 1). Figure 7 is the graph of the measured and analysis value of copper, nickel and chromium. The measured value of copper was less than the analysis value about 20%. For nickel, the difference between the measured value and the analysis value is less than 5 - 10%. The value difference between them is not so much. For the difference of nickel case, it can be explained by the difference of setting-up current efficiency.

The graph of thickness of three points of the parts arranged to rack No.1-5 in nickel plating was shown in Fig. 8. Though the measured value tends to be lower than the analysis value at the upper area, they are close enough. Furthermore, the analysis data showed the tendency that the parts distance and the angle variation have the similar performance result.

Conclusion

The thickness distribution with copper, nickel, and chromium plating for the complicated shaped parts were calculated to be compared with the measurement data. The measured value and the analysis value was close enough. We can conclude and offer that this program can supply the enough accurate back-up to you.

Acknowledgement

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References

1. K. Ohara, H. Hatase, and T. Sakurai; Hyomen Gijutsu, 47, 751(1996)
2. K. Ohara; Hyomen Gijutsu, 50, 416 (1999)

Table 1 . Specification of racks

No.	Distance (mm)	Angle (°)	Number of stages	Number of parts
1	110	0	8	16
2	110	15	8	16
3	110	30	8	16
4	150	15	6	12
5	200	15	4	8

Table 2. Plating condition

Plating process	Time (sec)	Current (A)		
		Rack1,2,3	Rack4	Rack5
Copper strike	280	12	12	12
Copper sulfate	1490	260	200	130
Semi bright nickel	550	200	150	100
Bright nickel	810	220	165	110
Post nickel strike	125	55	40	30
Chromium	280	870	650	440

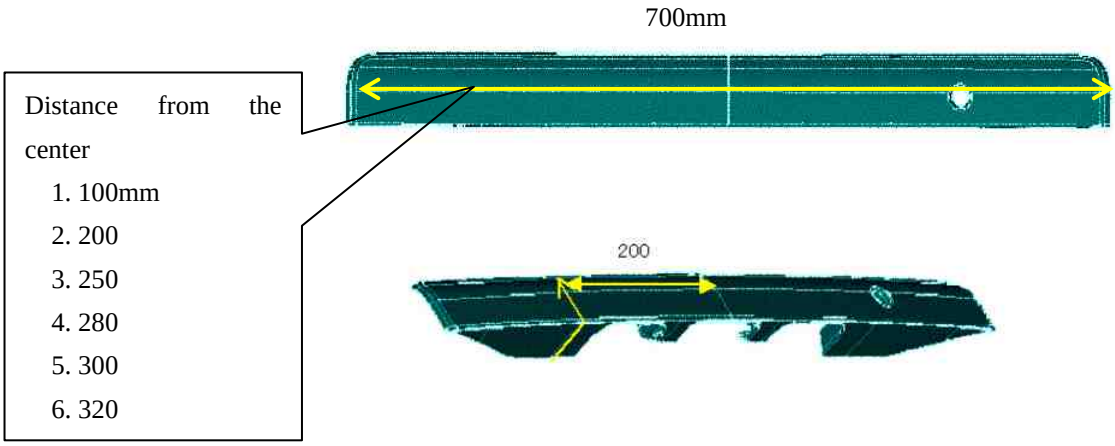


Fig. 1. Plating part

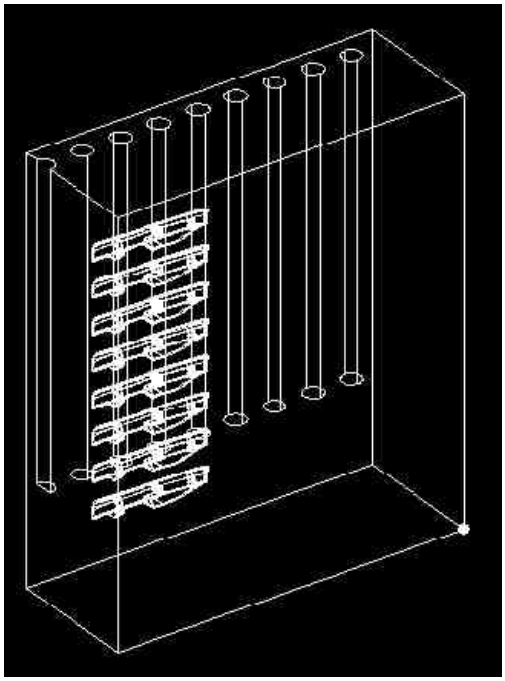


Fig. 2. Copper plating tank

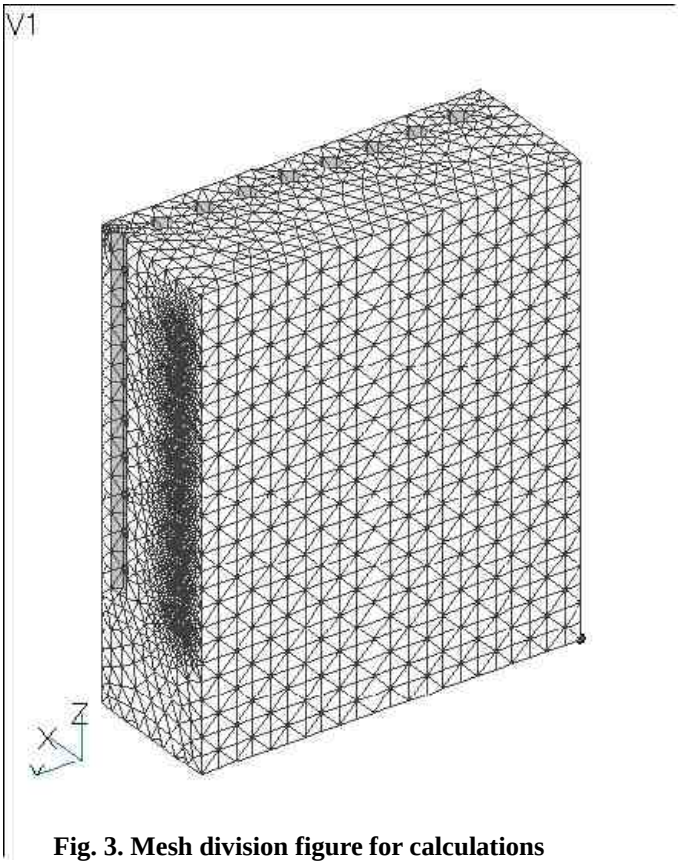


Fig. 3. Mesh division figure for calculations

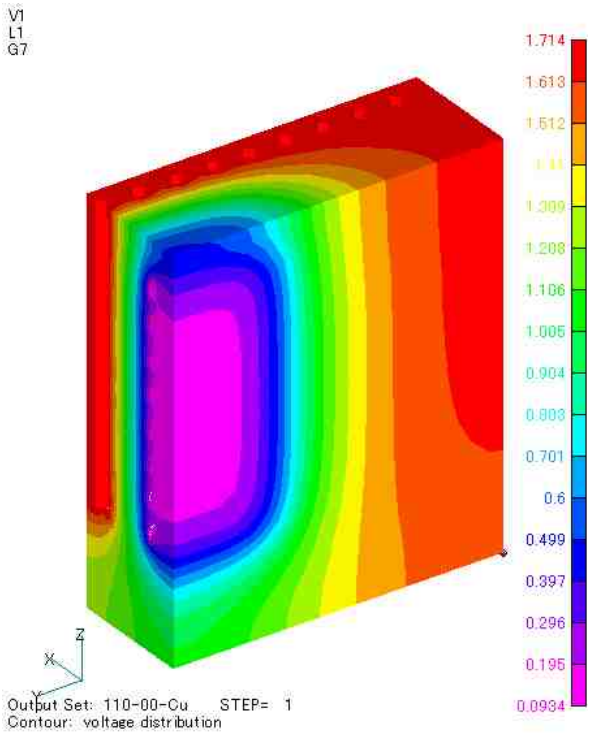


Fig. 4. Contour plot of voltage distribution (V)

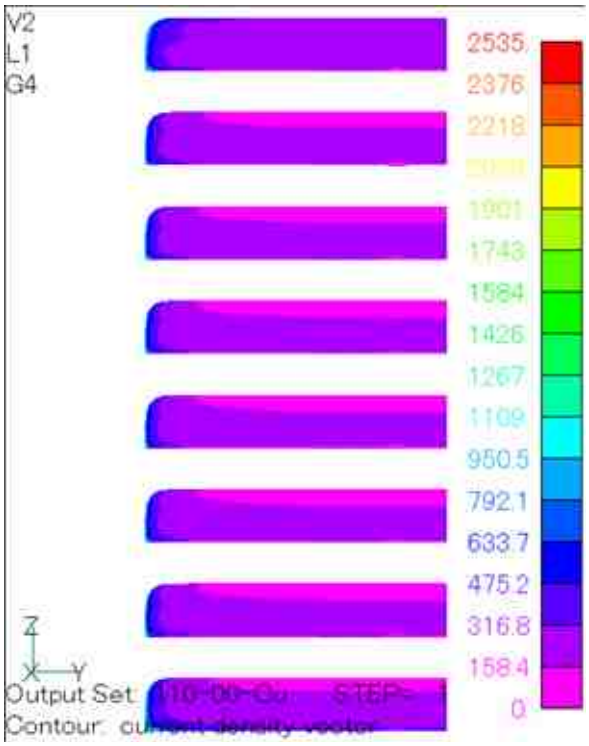
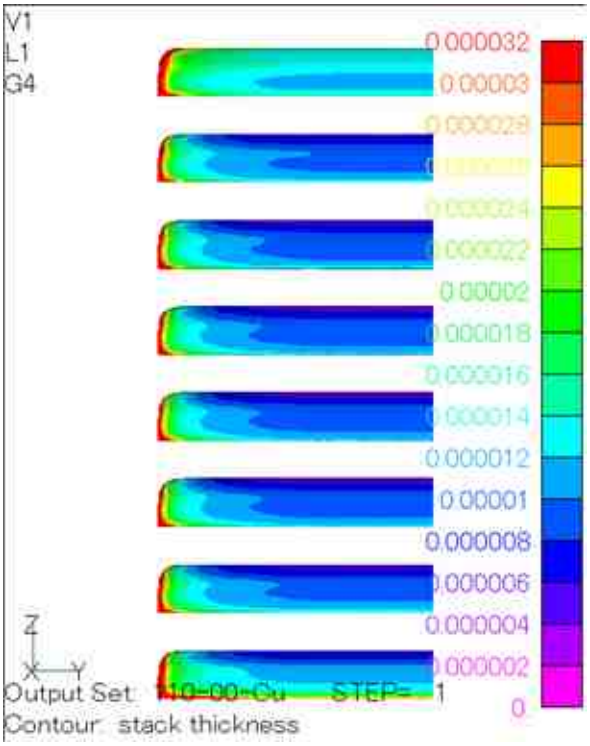
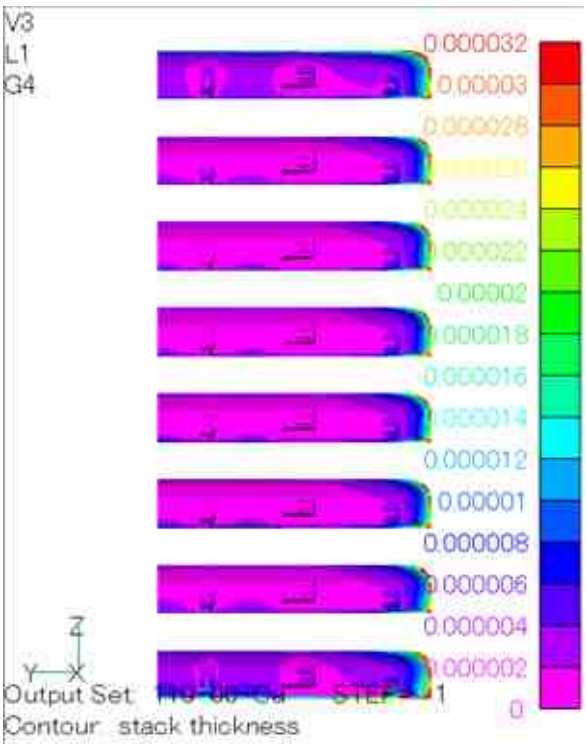


Fig. 5. Contour plot of current distribution on cathode (A/m^2)





a) Front view **b) Back view**

Fig. 6. Contour plots of deposit thickness distribution on cathode (m)

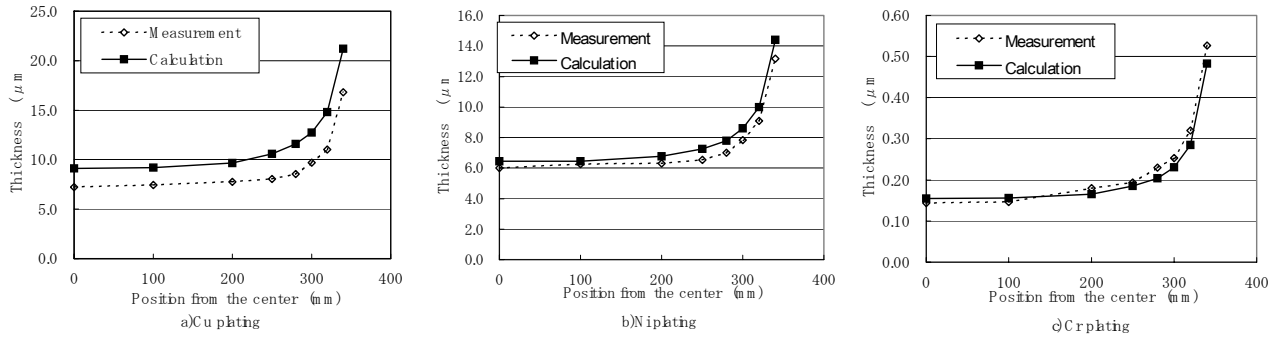


Fig. 7. Thickness comparison of the transverse direction

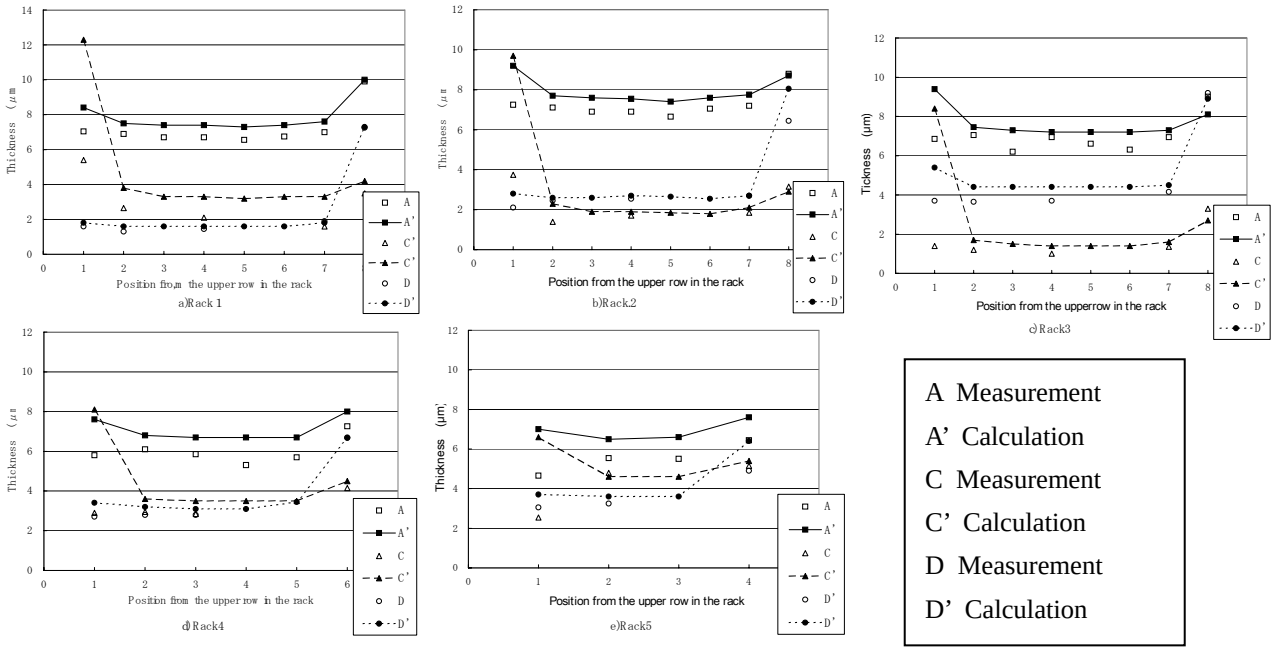


Fig. 8. Thickness comparison of racks