Plateability analysis for the decorative chrome plating process of a fog lamp bezel part

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In this paper a plateability analysis for the decorative chrome plating process of a fog lamp bezel part is presented, comprising a computer simulation of the copper, nickel and chrome metal thickness distributions over the part. The plateability analysis is based on a single part in a plating tank segment, and takes the tank dimensions and distance to the neighboring parts into account. Based on these simulations, different process parameters can be investigated: maximal possible rack load; the necessity for additional tooling on the rack in order to meet specifications; and the total metal deposit and plating time as required for each plating step. For a company involved in the decorative plating process of plastic or metal parts, this is all vital information for generating competitive but still profitable quotes towards customers, without risking underperformance and related warranty issues.

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1 Introduction

The plateability analysis for decorative chrome plating processes on plastic parts comprises a fast investigation of the copper, nickel and chrome layer thickness distribution over a part by means of computer simulations, in order to get a first idea whether the part can be plated up to specifications without additional tooling, as for example current robbers, conforming (auxiliary) anodes and insulating shields. If layer thickness specifications are not met, several problems might occur:

- Ni show, i.e. spots without chrome coverage (typically yielding a yellowish color);
- failure during the CASS salt spray tests (due to insufficient thickness of semi-bright, bright and microporous layer thickness values).

The plateability analysis is based on a single part in a plating tank segment, and keeps track (on an approximate base) of tank dimensions and distance to the neighboring parts. Simulations are based on bath characteristics from some common acid copper, semi-bright nickel and chromic acid baths as distributed by the main bath suppliers (e.g. McDermid, Atotech, Enthone), or they might be based on the exact bath characteristics from the plating line that is going to be used to plate the parts, if these data are readily available. The total imposed current is based on a recommended value for the average current density over the plateable area. By multiplying to the total plateable surface area per part, the total current to be imposed is obtained. In this plateability analysis, the effect of the different copper plating steps (that is copper strike and acid copper) and the different nickel plating steps (semi-bright, high sulfur, bright, micro-porous) can be bundled into one single 'virtual' plating step, in order to reduce computational and representational efforts.

The computer simulations for this type of plateability analysis can be performed using Elsyca's CAD integrated PlatingMaster software technology.

2 CAD model

Before any computer simulation can be performed on a part, the CAD model for this part should be repaired and simplified: Different repair operations are generally required:

- trimming of surfaces (edges not perfectly joined);
- combining surfaces;
- deleting small details (in order to reduce required computational resources).

Figure 1 shows the fog lamp bezel part that is subject to investigation in this paper.

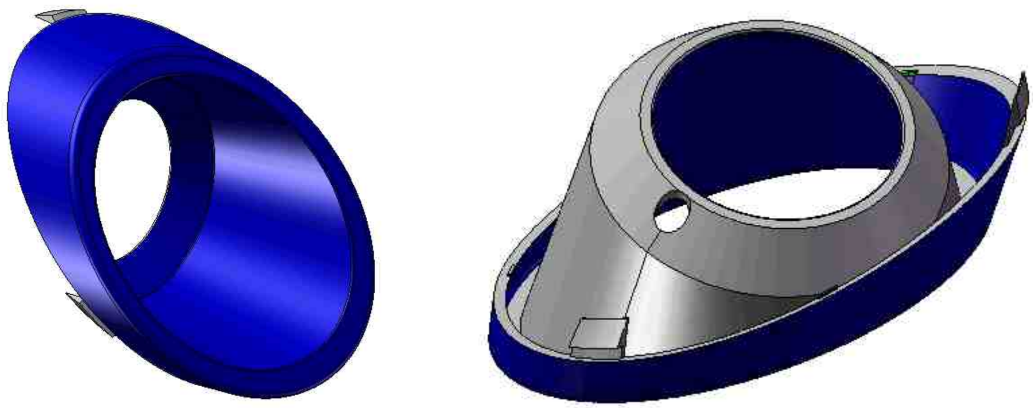

figure 1: CAD description of a GM fog lamp bezel part

3 Surface categories and layer thickness specifications

In most cases, not all surfaces of a part need plating. For automotive parts, a possible classification is as follows. 'A' type surfaces are exposed frontal view surfaces. 'B' type surfaces have only exposure by side view (not present for the fog lamp bezel) and 'C' type surfaces are not visible when mounted on the car or truck (hence the entire back side of the parts). In figure 1, the frontal surfaces in dark blue are A type, while the surfaces in light grey are C type.

Commonly used layer thickness specifications for the A type surfaces on ABS parts are 15 micron Cu, 20 micron Ni and 0.25 micron Cr. The Cu layer gets contributions from the copper Strike and acid copper plating steps, implying that the spec can be subdivided as roughly 2 micron for the copper strike plating step and 13 micron for the acid copper step. The Ni layer receives contributions from all 4 Ni plating processes. Taking into account the respective plating times and applied currents for the subsequent Ni plating steps, this translates in +/- 12 micron for the semi-bright Ni layer and 8 micron for the total high S / bright / micro-porous Ni layer (or 5 micron for the single bright Ni step).

4 Process conditions

The process conditions as applied for the computer simulations of the fog lamp bezel part are listed in table 1 (for this example the copper and nickel steps have not been bundled into single 'virtual' plating steps).

	acid copper	semi-bright nickel	chrome
Plating time	22 min	16 min	3 min
Average current density	4 ASD	4 ASD	14.4 ASD
Current per part	15.6 A	15.6 A	54.8 A
Plated metal	6.8 g	3.5 g	0.05 g

table 1: plating process conditions

5 Layer thickness distribution results

5.1 acid Cu

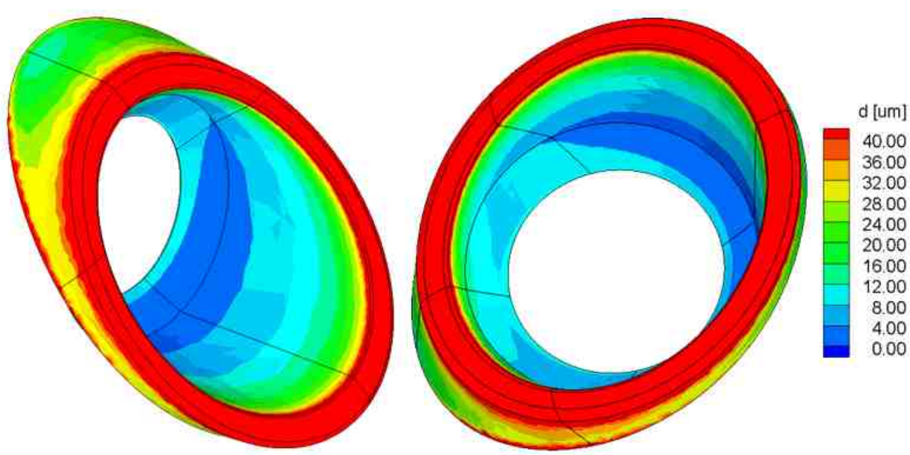

figure 2: acid copper layer thickness distribution

For the acid copper plating step, also a validation of the computer simulation results to experimentally obtained data has been performed. The definition of the sample points is given in figure 3, and comparison between measured and simulated layer thickness values is made in figure 4.

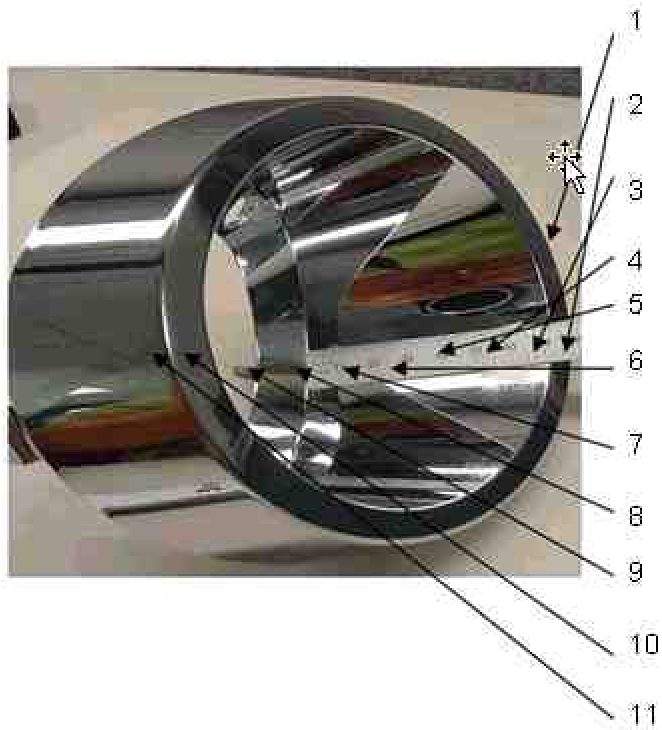

figure 3: definition of sample points

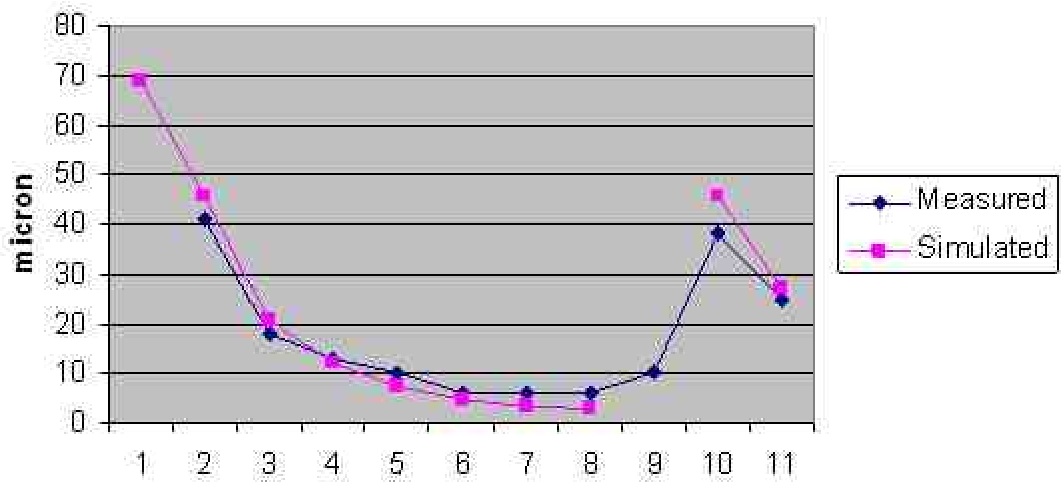

figure 4: acid copper layer thickness values in sample points

5.2 semi-bright Ni

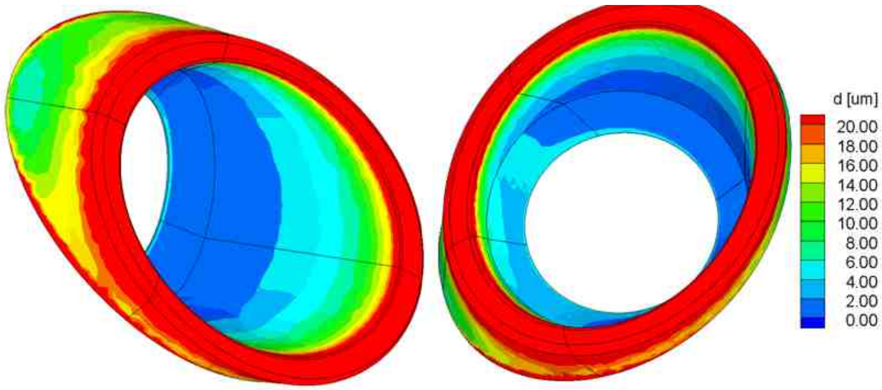

figure 5: semi-bright nickel layer thickness distribution

5.3 hexavalent Cr

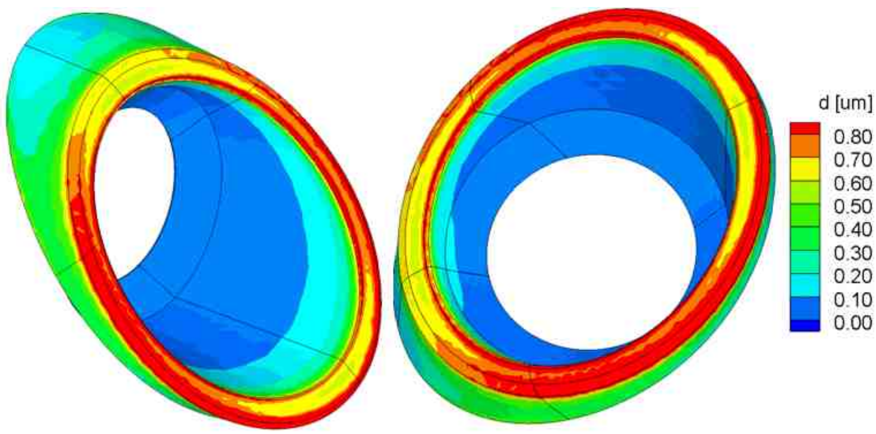

figure 6: chrome layer thickness distribution

6 Conclusions

It has been demonstrated that the simulated layer thickness values are in very good agreement with reality, thereby proving the reliability of the computer simulated layer thickness results.

The recessed surface areas of the fog bezel opening receive very low copper and nickel layer thickness values, the chrome layer even being completely absent over a large surface area in the fog bezel opening (= nickel show). Hence it follows straightforward that this part can not be plated up to specifications without the use of a conforming anode structure.

This fog bezel part is of relatively simple geometry, and the judgment on plateability can also be made simply based on experience, by any plating operator with a sufficient track record in the decorative chrome plating business.

However, this computer based plateability analysis works also without any problem for parts like grilles, wheels and fender vents, all parts of more complex geometrical nature where a plateability analysis can not be made confidently when solely based on the operators' experience.