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APPLIED SURFACE CONCEPTS
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ADHESION OF SIFCO DALIC PROCESS DEPOSITS

Quantitative measurements of the adhesion of electroplates are time consuming and expensive. One of the better methods involves plating 0.090 in. of material or more on the end face of a rod, and then pulling the rod through a matching hole in a tensile test machine. The electroplate which extends past the hole provides the resistance necessary for determining adhesion.

The high cost involved in obtaining quantitative data results in there being little data available on tank or SIFCO DALIC Process deposits.

Some testing, however, has been done attempting to obtain quantitative numbers on the adhesion of SIFCO DALIC Process deposits. The tests were run in accordance with ASTM C633-79 entitled "Standard Test Method for Adhesion or Cohesive Strength of Flame-Sprayed Coating". Simply described the test involves:

1. Plating the end faces of two 1 in. diameter rods.
2. Cementing the plated end faces together.
3. Pulling on the ends of the cemented together rod in a tensile test machine.

The results were as follows:

System Tested	Failure at psi	Failure
Babbitt Code 4009 on Steel	1,740 on 1 sample	Cement off Cement
Nickel Code 2085 on SAE 4130	11,300 average on 4 samples	Cement off Cement
AeroNikl® 250 Code 7280 on SAE 4130	10,090 on 1 sample	Cement off Cement

Since in the above tests failure occurred in the cement, the actual bond or cohesive strength was not determined. However, minimum values were established and they were:

Babbitt Code 4009	-	1,740 psi
Nickel Code 2085	-	11,300 psi
AeroNikl 250 Code 7280	-	10,090 psi

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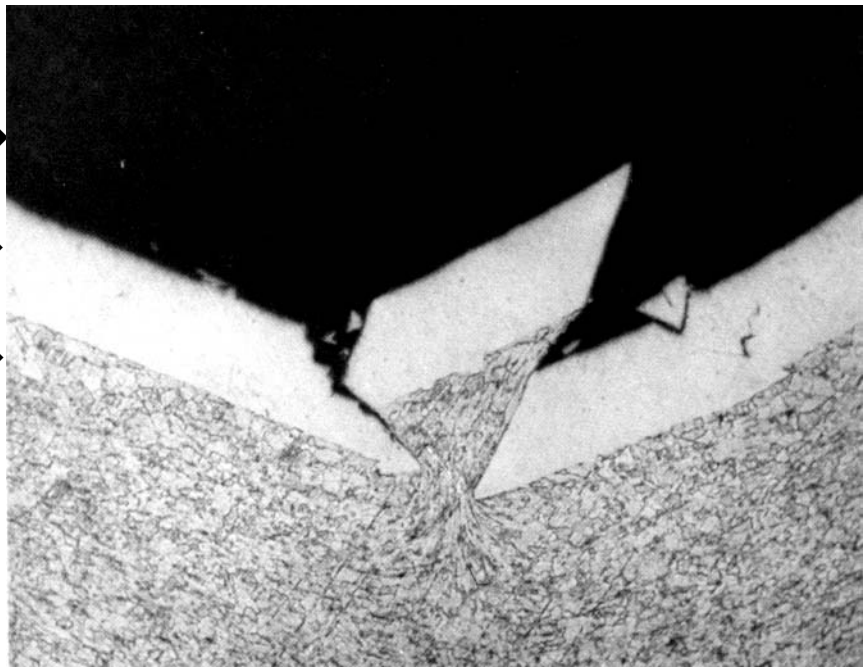
The high cost of obtaining quantitative data results in the electroplating field relying heavily on qualitative tests for adhesion. The better qualitative tests involve placing the plating to base material interface area under high stress and strain, and then observing what happened at the interface area. QQ-N-290A, the Federal Specification for Nickel Plating, gives the following as adhesion tests to be performed.

> "Adhesion may be determined by scraping the surface or shearing with a sharp edge, knife, or razor through the plating down to the basis metal and examining at four diameters magnification for evidence of non-adhesion. Alternately, the article or specimen may be clamped in a vise and the projecting portion bent back and forth until rupture occurs. If the edge of the ruptured plating can be peeled back or if separation between the plating and the basis metal can be seen at the point of rupture when examined at four diameters magnification, adhesion is not satisfactory."

The following photomicrographs show the excellent results obtained with similar types of tests on various SIFCO DALIC Process deposits on various base materials.



120X Magnification. Cobalt Code 2043 was plated 0.004 in. thick on a low carbon steel panel 0.030 in. thick. The panel was then bent 90º putting the plating in compression. The photomicrograph shows the bend area. The high stress extruded the base material out between the plating and/or the plating wedged into the base material from both sides.

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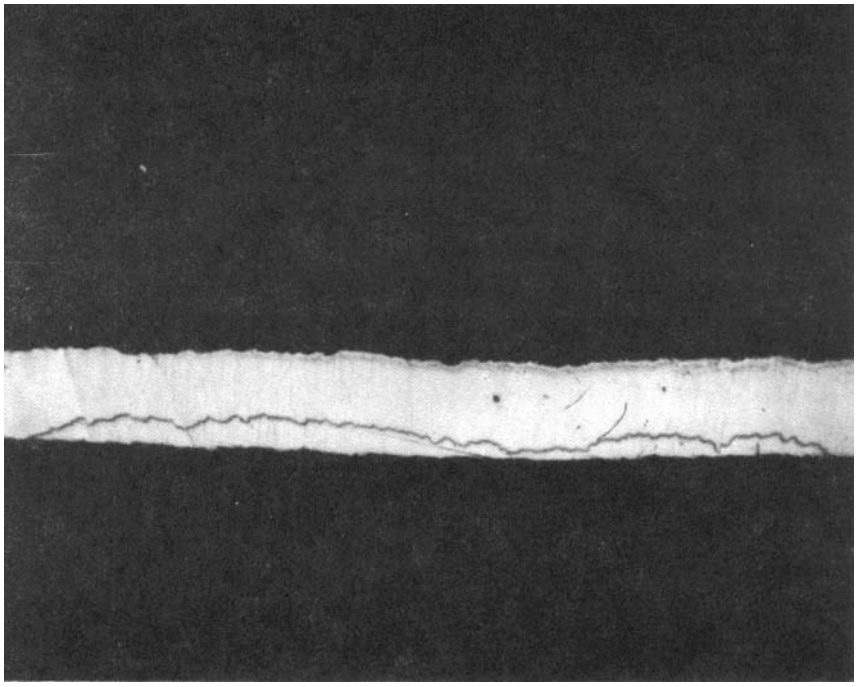
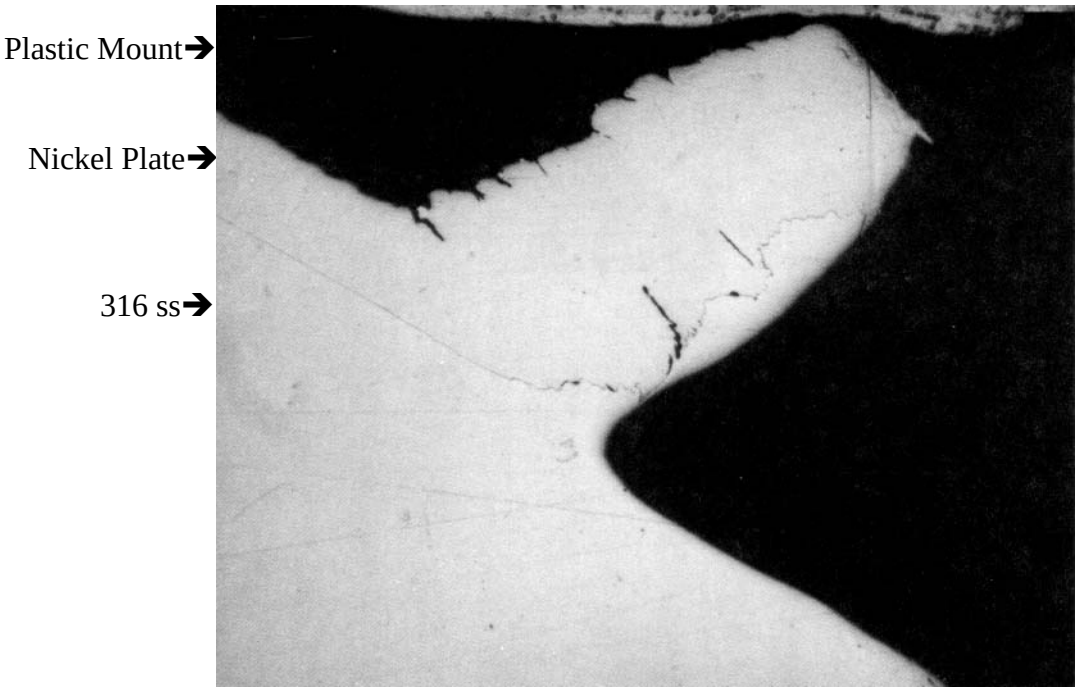


59X Magnification. Copper Code 2050 was plated 0.010 in. thick, out in the field on a contract job. The area being plated was a flat surface measuring 4 in. x 72 in. The base material was a high chromium steel of the following composition:

C 0.15%, Cr 8 - 10%, Mo 0.90-1.10%.

The purpose of the plating was to supply stock so that the surface could be trued up. The surface after plating, therefore, had to be machined on a horizontal planer with a 1 in. wide planer bit. One in. wide x 0.008 in. thick chips resulted. In some areas the bit cut into the base material. The photomicrograph shows a cross-section of a chip, that is, the tool bit had moved perpendicular to the surface of the photomicrograph. At the extreme right and left copper was machined off of copper, but in the central area some of the base material was removed with the copper.



59X Magnification. Nickel Code 2080, 0.008 in. thick, plated on 316 ss. The adhesion was checked by chiseling into the base material coming in from the right. The chiseling deformed the surface and picked up a burr, which is what is being shown projecting to the upper right corner. There is obviously no separation of plating from base material.

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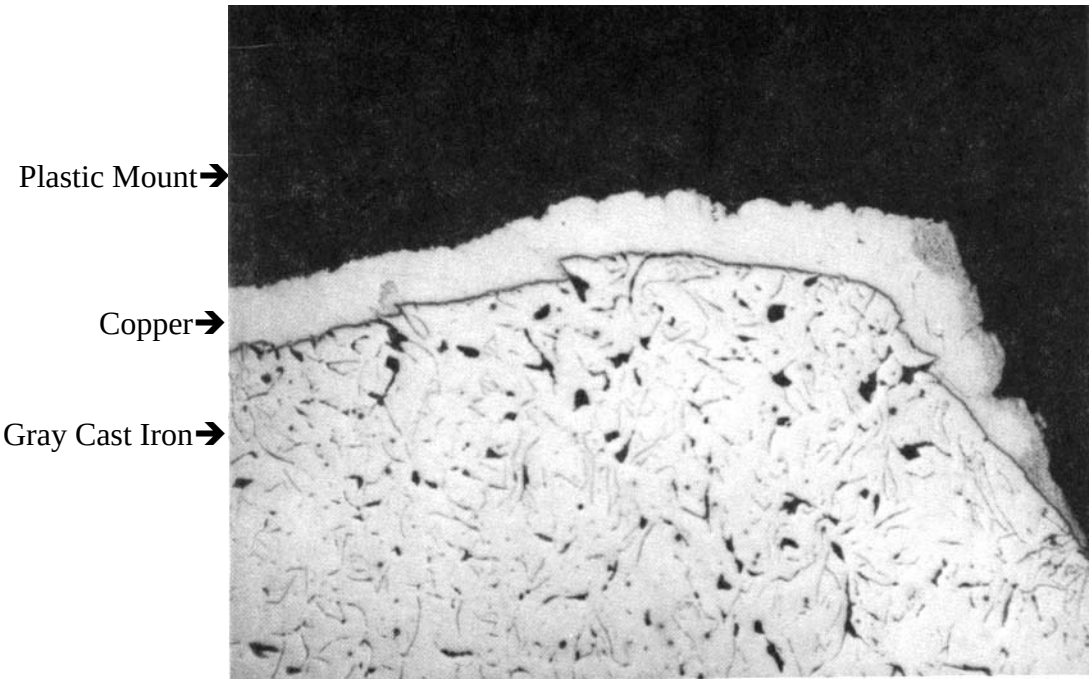

59X Magnification. Copper Code 2050, 0.005 in. thick, plated on gray cast iron. The plated surface was parallel with the bottom of the photograph. The adhesion was tested by hitting the upper right corner with a hammer coming in from the right side. The blow moved the corner left and up. The photomicrograph shows the raised deformed corner. Note the rough plating to cast iron interface resulting from the deformation of the base material and the absence of any separation of the plating from the base.

This Technical Service Bulletin is intended to provide supplementary information to that found in the latest edition of the SIFCO Process Instruction Manual. Changes and/or improvements in technology may require further modification of this bulletin.