Rosenberger®

AuroDur

Plating for RF Coaxial Connectors

AuroDur Plating

Gold has long been used to plate radio-frequency connectors proving excellent in terms of anti-corrosion, signal transmission and solderability. Rosenberger has accumulated a wealth of expertise and many years of experience in the electroplating of standard and customized surfaces.

Rosenberger consequently developed **AuroDur** gold plating that fully satisfies the high mechanical and electrical demands of radio-frequency connectors. In contrast to conventional platings, essential properties are improved.

Properties

The **AuroDur** surface consists of a thin gold layer on a non-magnetic, chemically deposited layer of nickel:

- 2-3 µm Ni, 0.15 µm Au.

The special **AuroDur** composition exhibits superior technical properties accompanied by excellent price/performance:

- Highly resistant to abrasion after multiple matings
- Very good corrosion resistance
- Non-magnetic, superb intermodulation rejection
- Low contact resistance
- Excellent solderability and adhesion of soldered connection with minimal embrittlement and solder bath contamination
- Optimal distribution of layer thickness
- Highly economical
- RoHS compliance to EU directive 2002/95/EC

Verification tests

Verification tests, conducted by highly reputed and independent research institutes such as the Fraunhofer-Gesellschaft, confirm the outstanding properties of **AuroDur** gold plating.

Please see the results of the verification tests on the following pages. Unless otherwise noted, the target values stated in the tables correspond to the specifications of each tested coaxial connector series.

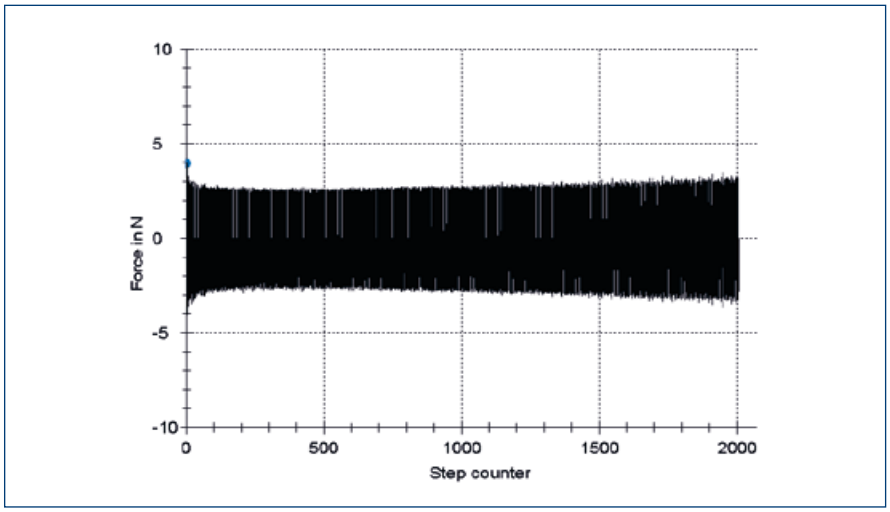
Rosenberger plating shop

Mating Cycles

The usual requirement of coaxial connector systems in radio-frequency engineering is 500 mating cycles. To test the durability of **AuroDur** plating, connectors of the SMP series were tested for 1 000 reconnect cycles.

Test method:

- IEC 60169-1, clause 17 (mechanical endurance)



Insertion force for 1 000 reconnect cycles (1 cycle = 2 steps) on a typical coaxial connector of the SMP series

Test equipment:

- Zwick/Roell, Zmart.Pro test machine

Test parameters:

- Mating cycles: 1 000
- Speed: 300 mm/min

Test apparatus

Result:

Outer conductor contact resistance [mΩ] (on typical coaxial connectors of the SMP series)		
		Target
Values before load	0.20–0.33	≤ 2.00
Values after load	0.31–0.45	≤ 5.00

A load of 1 000 reconnect cycles produces a negligible change in contact resistance.

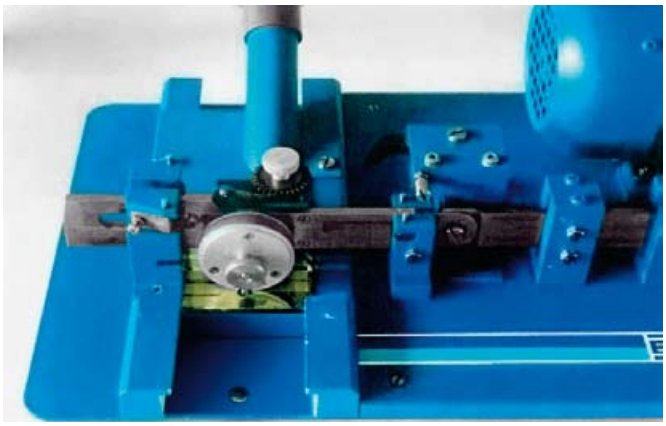
Abrasion Resistance

The abrasion resistance of the surface was tested by the Bosch-Weinmann method.

Test method:

Special sandpaper with a 1 000 grain is drawn at a defined pressure across brass specimens plated with **AuroDur** and with a standard gold surface.

The number of double strokes until the surfaces of the samples is rubbed through is a measure of plating quality.



Apparatus for the Bosch-Weinmann test

Result:

Number of double strokes until nickel layer is rubbed through:	
AuroDur surface (2–3 µm chem. Ni, 0.15 µm Au)	400 double strokes
Standard surface (2–3.5 µm galv. Ni, 0.8 µm Au)	370 double strokes

The **AuroDur** surface with a 0.15 µm thick gold layer and conventional surfaces with a 0.8 µm thick gold layer are equivalent in abrasion resistance.

Corrosion

Test method:

- Flowing mixed gas to EN 60068-2-60, test Ke
- Method 4 (H_2S, NO_2, Cl_2, SO_2)
- Duration: 10 days

Both specimens with (100 cycles) and without previous reconnect cycle load were subjected to the test. Both connected and unconnected specimens were exposed to the flowing mixed gas. Outer conductors of the SMP coaxial connector series and inner conductors of the SMA coaxial connector series were tested.

- Tested surface: **AuroDur**

Test chamber

Positioning of specimen

Result for contact resistance [mΩ], SMP series (outer conductor) during mixed gas exposure:

		without reconnect cycles	with previous 100 reconnect cycles	
	Initial values	Values after mixed gas exposure	Values after 100 reconnect cycles	Values after mixed gas exposure
connected	0.17–0.37	0.20–0.63	0.21–0.29	0.35–0.43
not connected	0.17–0.22	0.26–0.42	0.25–0.30	0.45–0.48
Target	≤ 2	≤ 5	≤ 5	≤ 5

Result for contact resistance [mΩ], SMA series (inner conductor) during mixed gas exposure:

		without reconnect cycles	with previous 100 reconnect cycles	
	Initial values	Values after mixed gas exposure	Values after 100 reconnect cycles	Values after mixed gas exposure
connected	1.51–1.84	1.69–2.78	1.51–1.77	1.60–1.69
not connected	1.49–1.83	2.43–3.45	1.64–1.69	2.59–2.88
Target	≤ 5	≤ 8	≤ 8	≤ 8

All specimens meet the specifications of the SMP and SMA connector series after exposure to the mixed gas. The results are far below the permissible limits.

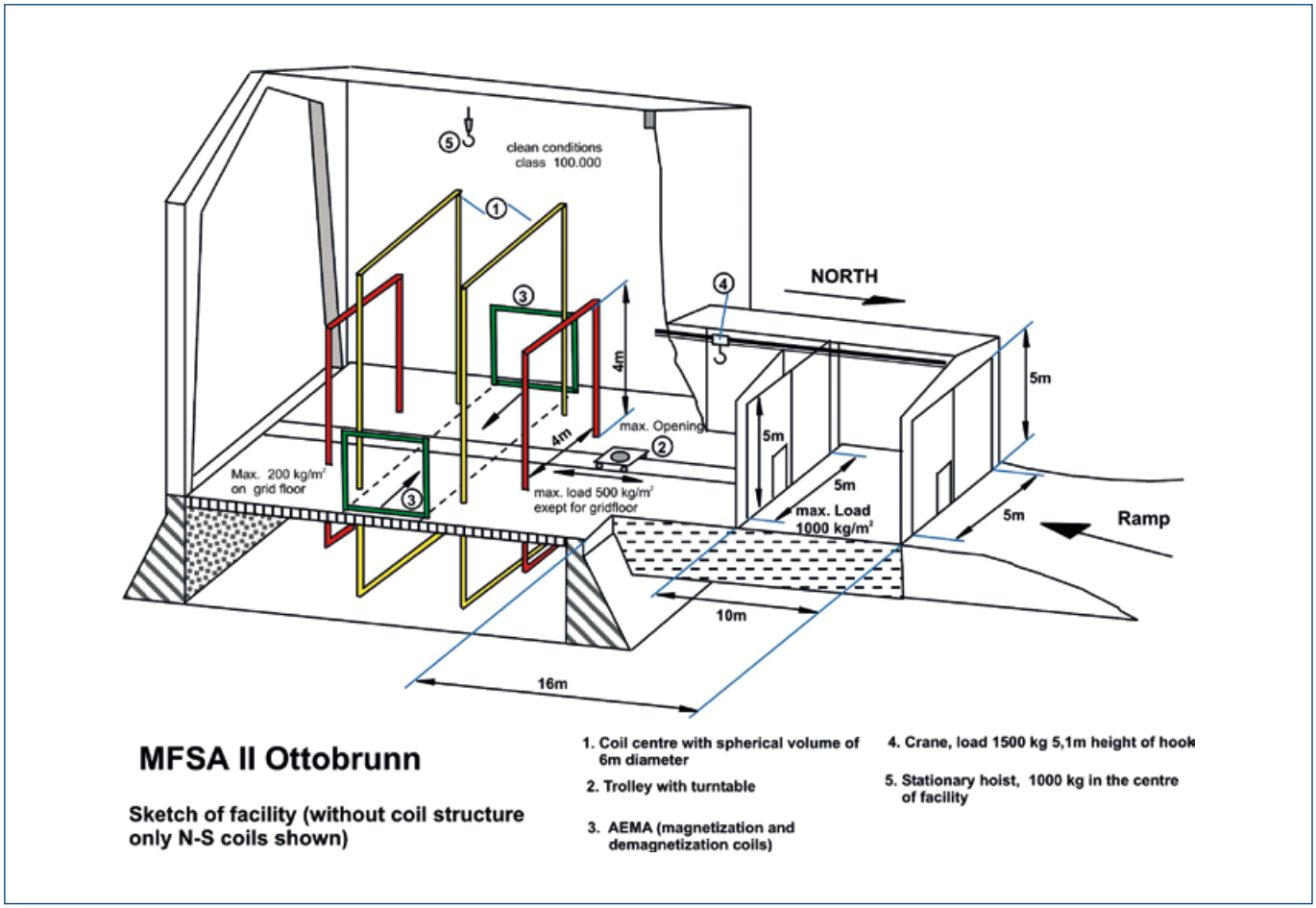
Magnetism

Chemical nickel with a phosphorus content of at least 10.5 % is used as the under-plate for the **AuroDur** surface. This high phosphorus content suppresses the ferromagnetic properties of the nickel. For this reason the **AuroDur** surface is absolutely non-magnetic and consequently possesses excellent intermodulation properties.
An examination of magnetic field emission was performed on standard coaxial connectors of the SMP series.

Test method:

- ESA/SCC generic specification no. 3402, issue 8

The connectors were exposed to a magnetic field of 20 mT (millitesla) on three axes. The maximum magnetic field emission was measured 5 mm away from the connectors.



Magnetic field simulation facility

Result:

Maximum magnetic field emission in [nT] (nanotesla)	
Measured values	10–100
Target	≤ 432

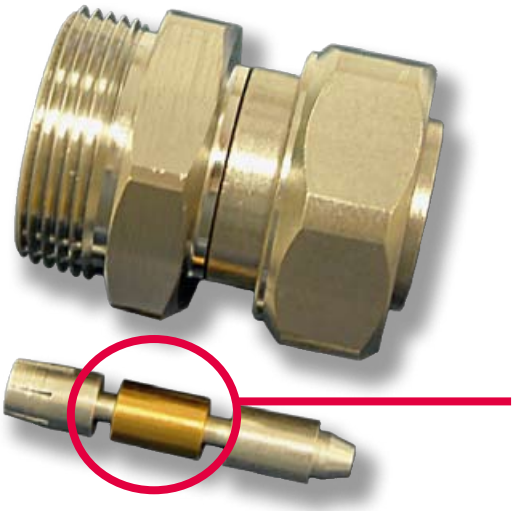
The results are far below the permissible limit, meaning that the specimens can be termed non-magnetic.

Intermodulation

Intermodulation is produced on passive components whenever multiple, high power signals appear simultaneously and a nonlinear response is created on the components. The reasons for this can be corroding surfaces, for example, or poor contact. The use of ferromagnetic materials or coatings is also a major contributor. The undesirable signals can have a substantial negative effect on communication systems and need to be minimized.

The following method involved intermodulation tests on standard 7-16 coaxial connectors.

Test method (IEC 62037):

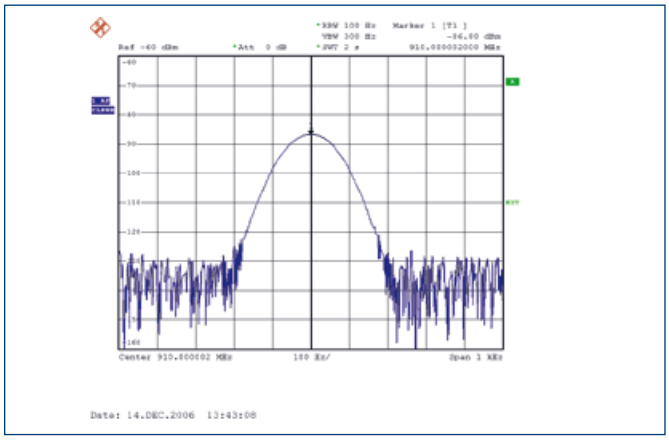


Specimen: brass sleeve with various surfaces

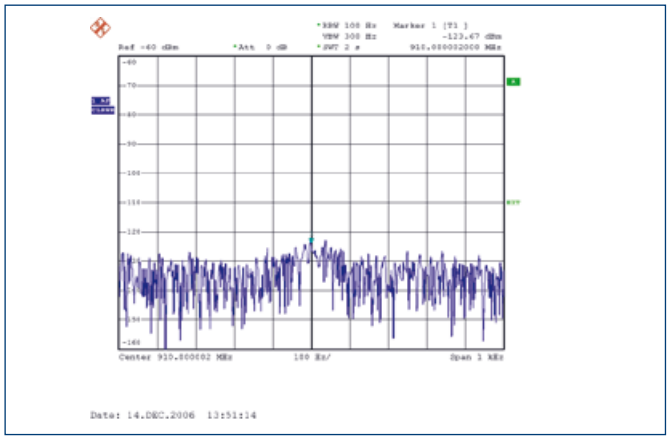
Test receptacle (male/female adaptor type 7-16)

Test apparatus

Result:



IM plot with electrolytic nickel as barrier layer



IM plot with chemical nickel as barrier layer (**AuroDur** surface)

Passive intermodulation at 910 MHz [dBc]	
AuroDur surface (2–3 µm chem. Ni, 0.15 µm Au)	≤ -165
Conventional surface (2–3.5 µm galv. Ni, 0.8 µm Au)	≤ -125

f_1 = 935 MHz, f_2 = 960 MHz, f_{IM3} = 910 MHz, P (f_1) = P (f_2) = 20 W (= 43 dBm)

Non-magnetic **AuroDur** has no negative effect on signal transmission rate.

Contact Resistance

Measurement of contact resistance on two typical coaxial connector types (SMA inner conductor and SMP outer conductor).

Test method:

- IEC 60169-1, clause 14.3 (contact resistance)

Test equipment:

- HIOKI 3560 AC mΩ HiTester

Test parameters:

- Measurement frequency: 1 kHz
- Measurement current: 1 mA

Result:

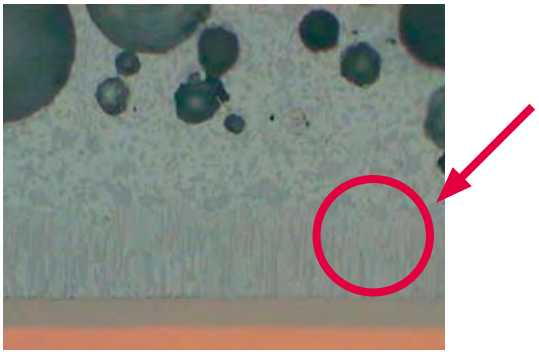
Contact resistance [mΩ], outer conductor, SMP connector		
	Values	Target
AuroDur surface (2–3 µm chem. Ni, 0.15 µm Au)	0.17–0.27	≤ 2.00
Standard surface 1 (2–3.5 µm galv. Ni, 0.8 µm Au)	0.18–0.23	≤ 2.00
Standard surface 2 (2–3 µm chem. Ni, 0.8 µm Au)	0.19–0.27	≤ 2.00

Contact resistance [mΩ], inner conductor, SMA connector		
	Values	Target
AuroDur surface (2–3 µm chem. Ni, 0.15 µm Au)	1.49–1.84	≤ 5.00
Standard surface 1 (2–3.5 µm galv. Ni, 0.8 µm Au)	1.31–1.63	≤ 5.00
Standard surface 2 (2–3 µm chem. Ni, 0.8 µm Au)	1.45–1.80	≤ 5.00

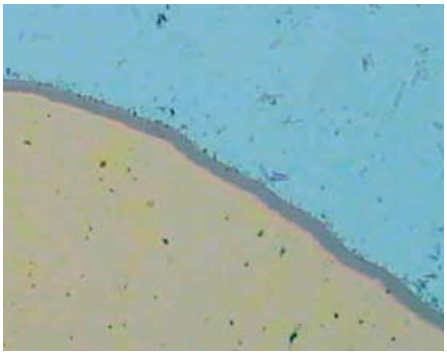
Hardly any differences were found between the surfaces tested for contact resistance. All values are far below the permissible limit. A thicker gold layer than **AuroDur** produces no advantages.

Solderability

Thick gold layers are a disadvantage in terms of solder bath contamination and soldered connection embrittlement. The layered structure of the **AuroDur** surface avoids this and produces very good solderability.



Embrittlement of the soldered connection on the boundary with the circuit board, caused by a thick gold layer



Soldered connection without embrittlement through the use of **AuroDur**

Pull-off Strength of Solder (F)

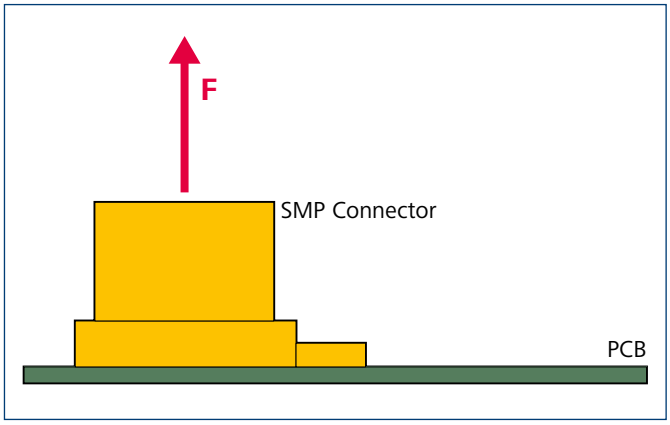
Test method:
Coaxial connectors of the SMP series (SMDs) were reflow soldered onto test boards, then the pull-off strength of the connector from the board was determined in an axial direction.

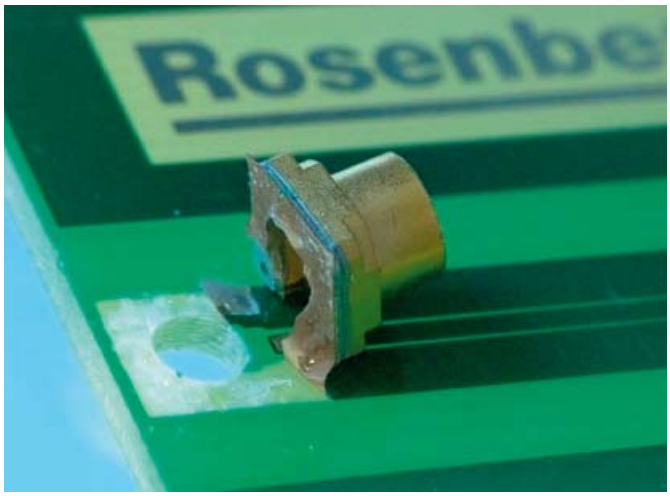
Test equipment:
- SMT 1.2 TC N_2 reflow soldering oven Zwick/Roell, Zmart.Pro test machine

Tin-lead solder used:
- Balver solder paste SN100C (SnCu 0.7 Ni)

Result:
- Min. pull-off strength: 254 N

In none of the specimens was the soldered connection destroyed. The strength of the solder was greater than the adhesion of the copper track on the substrate.



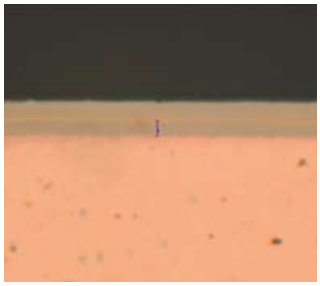


Layer Distribution

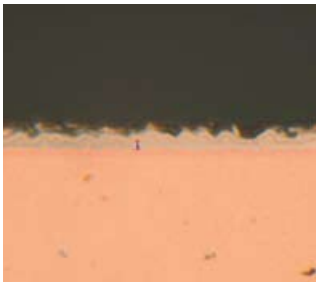
The use of **AuroDur** produces very good distribution of the nickel layer. Good coating is ensured in deep boreholes of small diameter. Dog boning or ossification of high current density areas is virtually eliminated.

Inner:

- **AuroDur**: normal layer structure
- Standard nickel: layer structure too thin



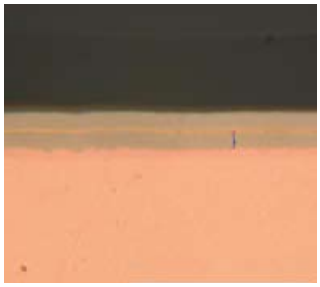
AuroDur



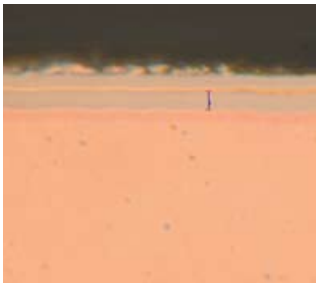
Standard nickel

Outer:

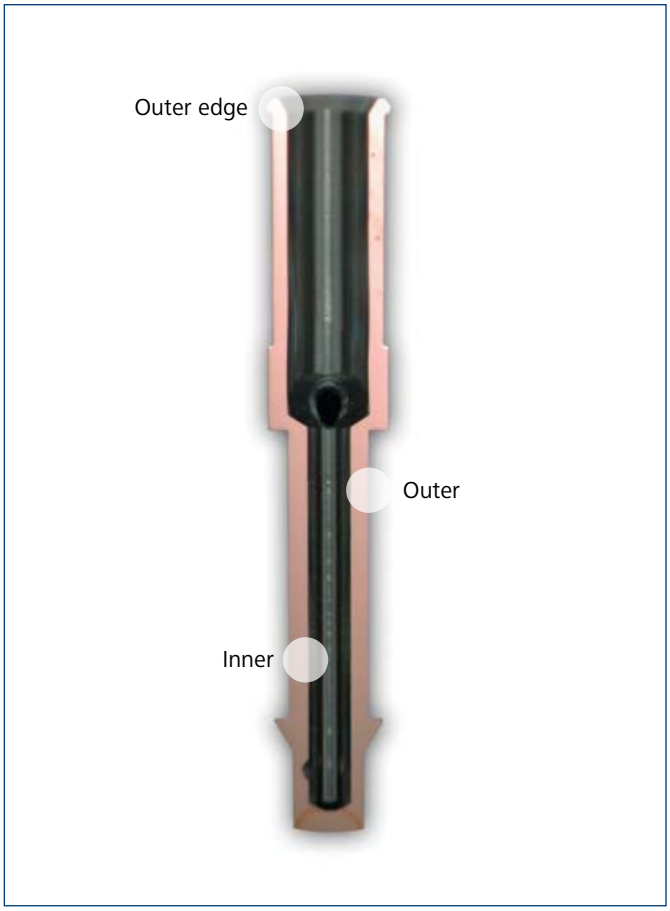
- layer structure of **AuroDur** and standard nickel comparable



AuroDur

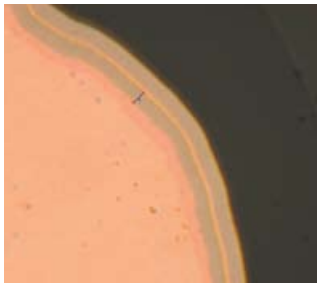


Standard nickel

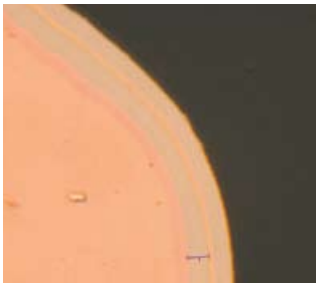


Outer edge:

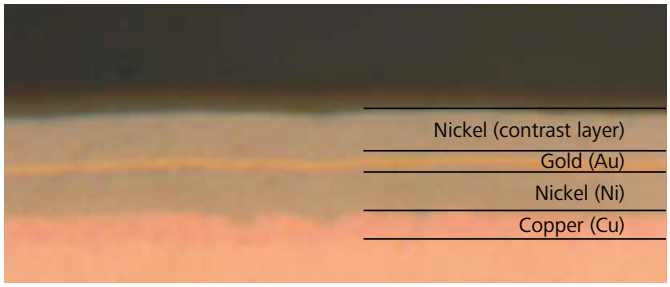
- **AuroDur**: normal layer structure
- Standard nickel: layer structure too thick



AuroDur



Standard nickel



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