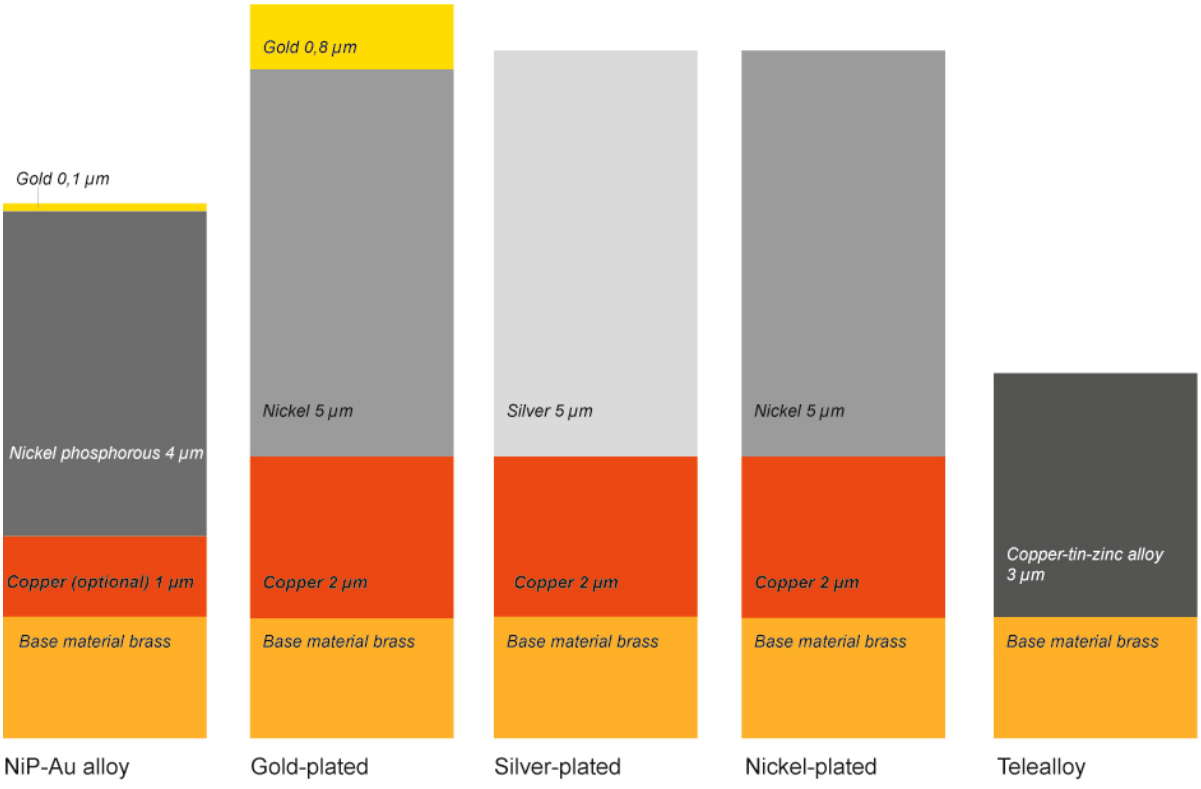
High in quality yet still economical -
Innovative surface coating for coaxial HF connectors

Connectors in high frequency technology are exposed to many demands and stresses. The surfaces of coaxial HF connectors are refined in order to meet these challenges. But the most sophisticated technical solution is not always the best overall. In our high-tech age, a technically excellent solution also or especially has to be economical too.

The surface refinement on HF connectors must ensure that the connection works reliably for a long time. Electrical, mechanical and chemical influences must be taken into consideration accordingly in the design and production which leads to various different demands.
The electrical demands include best possible contacting and interference-free signal transmission. The connection should also be as wear-resistant as possible (mechanical requirements) to reduce wear and thus replacement cycles or downtimes for replacement of the connection in device for example to a minimum. Corrosion protection is also one of the chemical requirements: The refined surface must protect the base material against destruction by environmental influences.

Solutions

Different variants with specific advantages and disadvantages are found in practice.



Frequently used materials for coaxial HF connectors

Silver has excellent electrical conductivity and – because it is not ferromagnetic – an equally excellent intermodulation strength but its wear resistance is the poorest of the materials mentioned above.
The copper-tin-zinc alloy Telealloy offers good wear resistance but the conductivity is way below that of the other materials.
Nickel would be a low-cost material but does not have very good intermodulation strength; its weak ferromagnetic properties are a disadvantage in intermodulation-sensitive applications. Nickel often also causes contact allergies.
And what about gold? Gold has indisputable advantages. In miniature connectors which typically transmit signals with low power, low contact resistances are required which can be achieved with gold or gold alloys. Gold is also an extremely robust material which is easy to process and solder.

Material property Surface material	Contact resistance	Conduc -tivity	Intermod. strength	Wear resistance	Solder- ability	Resistance	Ductility	Costs
Gold Cu1Ni2Au0.8	+++++	++++	-	+++	+++++	+++++	++	-
NiP-Au [NiP]4Au0.1	+++++	++	+++++	+++++	+++++	+++++	+	+
Silver Cu2Ag5_pas.	++++	+++++	+++++	+	++++	++++	+++	++
Optargen Ag2[CuSnZn]0.5	+++	+++++	+++++	++	+++	++++	+++	++
Telealloy [CuSnZn]3	++	++	+++++	++++	+++	++	++	+++
Nickel Cu2Ni5	+	+++	-	+++	-	+++	+	++++
Tin Cu1Ni2Sn3	+	+++	-	-	++++	+++	++	+++

Material properties in comparison

All that glitters is not gold

This old proverb has not lost anything of its validity at least in high frequency technology. Simply coating the brass base material with gold will not solve the problems mentioned above. On the contrary: Since the zinc atoms in the brass are much smaller than those in the gold, they would slowly but surely diffuse the gold coating to the surface. A barrier layer is needed between the two. Nickel is best for this and is frequently used as a diffusion barrier in practice. But is has one disadvantage: It does not bond well to brass.
Therefore a boding layer of copper must be inserted between the nickel barrier layer and the brass. This ensures that the nickel does not come loose even under heavy mechanical stress such as impact. Such a bonding layer is also required in connectors with a silver coating for example.
But gold has another much bigger disadvantage: It is expensive.
Whereas the price of gold remained stable for a long time during the 1980s, it has increased constantly since the turn of the millennium. It is six times more expensive on average since the year 2000 and there is no end of the price increase in sight.

The solution: Gold, finely dosed

In order to produce technically excellent and at the same time economical HF connectors, a gold plating over a base layer made of nickel-phosphorous alloy (NiP-Au) such as Tribor® has proven effective.
The nickel-phosphorous base layer is non-magnetic in its separated state and offers a hard, wear-resistant and corrosion-resistant surface. It is also very smooth so that there is much less wear in the plugging process and a thinner gold plating is possible than the conventional variant of gold on nickel. The strongly bonded gold-cobalt alloy on a NiP base layer has excellent sliding and wear properties. Much higher plugging cycles can be achieved than with conventional gold coatings.

Innovative solutions demand innovative techniques and processes

Whereas gold coatings are applied by galvanic methods, the production of NiP-Au alloys makes use of chemical processes. The separation principle is based on the potential differences between metal and electrolyte which is heated up to 85 °C. This method achieves an even coating thickness distribution. It is more expensive than galvanic processes but this is more than compensated by the use of less gold material so that the overall cost effectiveness is much higher.
The increasingly intense competition situation on globalised markets demands fast response to changing customer requirements today more than ever. The concentration of research, development, design, production and quality assurance at central location in Germany makes Telegärtner fit to face these challenges. "Made in Germany" still has technological and economical advantages.

Conclusion

Surface refinements with nickel-phosphorous-gold alloys (NiP-Au) offer clear advantages for coaxial HF connectors. They have excellent wear resistance and corrosion resistance, optimum sliding behaviour, good chemical resistance and low contact resistance. They can be soldered and welded and have high intermodulation strength.
In addition to their technical advantages, their optimised use of materials also brings clear economical advantages which will become more important as the gold price continues to rise.

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