In a video conference, the user succeeded in commissioning the nickel controller; a member of the manufacturer's staff went through each step on a second device with

New ENIG/ENEPIG process with virtual commissioning

PCB manufacturer Piu-Printex calls the conversion of its plating processes ‚open-heart surgery'. This was achieved over two consecutive weekends under pandemic conditions.

Piu-Printex from Vienna manufactures high-quality printed circuit boards and partly also processes them into assemblies - within the scope of prototype and small series production and especially for orders with demanding requirements. Customers include well-known names in the semiconductor industry and manufacturers from the EMS and PCB areas.

With the previous plating processes, the company would have foreseeably reached its limits - especially due to the high or currently strongly increasing qualitative requirements for solderability and wire-bondability. Therefore, the existing ENIG and ENEPIG processes were replaced.

In advance, the Viennese company had contacted the coating specialist Umicore Electroplating and described the problem: „In order to

achieve the surface quality required by our customers," says Georg Pohanka, the CEO of the family-run company, „we have already had to move the plating process in the PCB production far back in the production sequence. The reason for this are the surface-sensitive products, which must not show any scratches or dust grains.

A process changeover in plating processes always poses a great challenge. The chemistry has to be modified, partly exchanged and changes to the plating line itself have to be planned. Such interventions require on-site visits, which are just not possible in the middle of a pandemic. Instead of sending a technician to carry out the changeover and accompany the production process for at least two weeks, installation and process release were carried out purely online.

Piu-Printex found the ideal partner in Umicore Electroplating. Within a short time, the company from Schwaebisch Gmuend was able to transfer its decades of experience with a large number of successfully implemented process conversions online. The restart of production with the new chemistry had to succeed quickly. Only two weekends were available for the process conversion in order to be able to maintain ongoing production.

The different plating processes

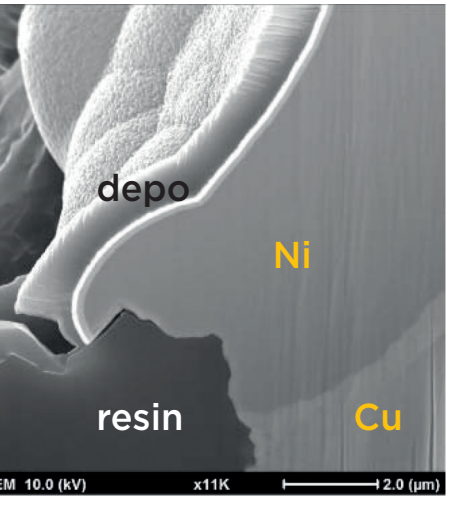
ENIG includes a layer sequence of nickel and gold on copper, while ENEPIG contains a further diffusion barrier of palladium between the gold and the nickel. The nickel layer is applied autocatalytically (electroless nickel). A reducing agent, which is oxidized on the Cu surface seeded with palladium under its catalytic effect, makes its electrons available to the nickel.

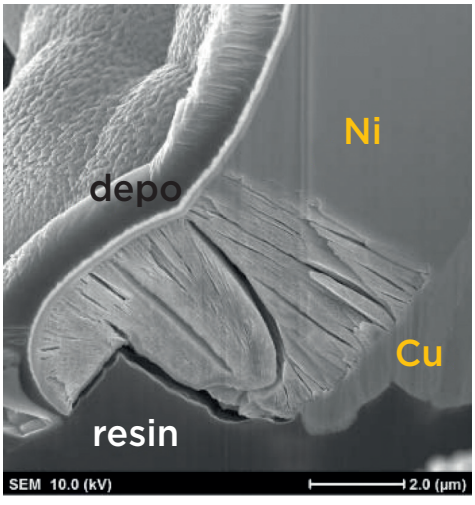
In both cases, the gold serves as corrosion protection - above all to ensure storability and further processability in the case of several assembly processes, which may also take place at different times. It is also crucial for reliable wire bondability and dissolves completely during soldering.

Up to now, gold deposition has been carried out by the immersion process (exchange or displacement process). This type of film deposition is possible if the metal to be deposited has a significantly higher potential (20-50 mV) than the substrate or the interlayer itself. In this process, the gold ions contained in the electrolyte pick up the electrons of the nickel going into solution and deposit metallically on its surface.

One of the disadvantages of this pure displacement process is the corrosion inherent in the process, which takes place when nickel dissolves. This has a negative impact on solderability, bondability and storability.

For the ENEPIG final finish, corrosion is even more critical than for the ENIG process. The palladium layer serves as a diffusion barrier. Like the nickel, it is produced autocatalytically. It is a very thin layer that has corresponding pores. These are necessary since gold deposition only takes place through the direct contact between gold and nickel. While the exchange process in ENIG is relatively uniform over the entire surface in the tenth of

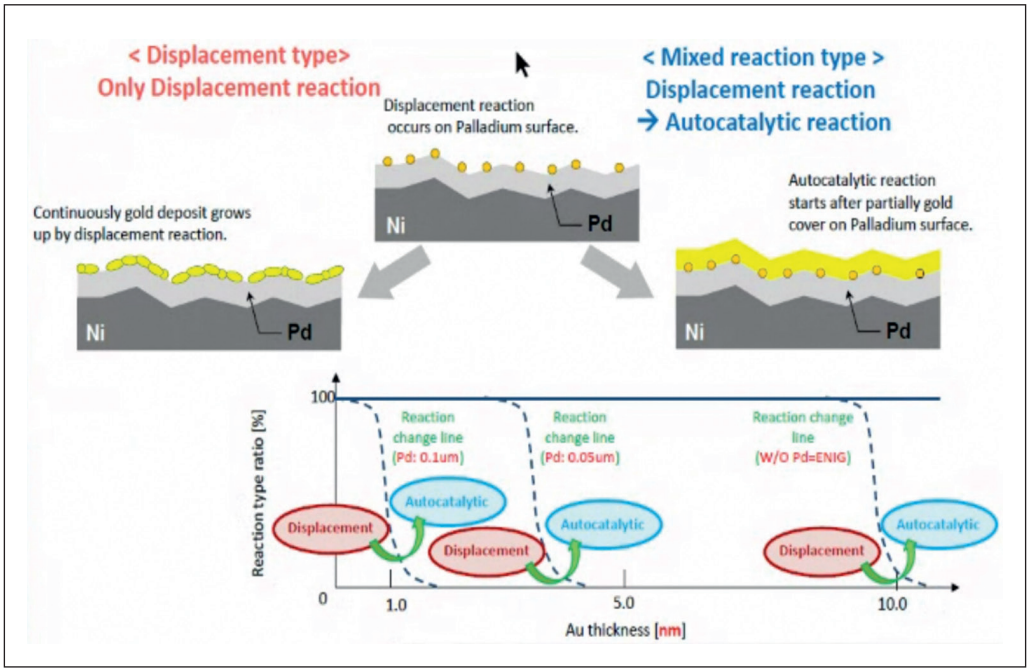




ENEPIG-film cross-section under the microscope: The Nickel/ Palladium/ Gold-layer structure in the Umicore process (left) is completely intact even at a drilled/milled edge where it is adjacent to the base material. A competitive process clearly indicates areas damaged by nickel corrosion

About the Person
Georg Pohanka leads PIU-PRINTEX GmbH in Vienna as CEO together with his strong management team

About the Person
Andreas Gross is responsible for customer projects for European printed circuit board customers at Umicore Electroplating



a micrometre range, it is significantly intensified in ENEPIG since the reduction of gold and thus the dissolution of nickel is limited to the pores of the palladium layer. The principle of this process is similar to the classic pitting corrosion known from other plating applications.

Further disadvantages are a limited gold layer thickness which is also unevenly distributed. The palladium layer has pores of different sizes, inhomogeneously distributed on the surface. The same applies to the subsequent gold plating by means of immersion plating. The geometry and structure of the conductors, which have different potentials depending on their dimensions, also complicate the process.

In order to solve the three problems (corrosion, layer thickness distribution and reduced layer thickness), the gold-plating process was changed to semi-autocatalytic gold deposition (SAG). A purely autocatalytic solution would not have been easily possible. As a rule, it does not develop on nickel surfaces and would therefore still have required prior immersion gold plating, which would have resulted in an additional process step. Furthermore, a purely autocatalytically deposited gold layer on nickel involves the risk of adhesion problems. In extreme cases, the gold can be peeled off as a film.

SAG is a new development and combines the advantages of both processes. It starts with the charge exchange process but spontaneously starts the autocatalytic deposition as soon as the first gold atoms cover the nickel. Afterwards, autocatalysis dominates, reducing the attack on the nickel layer by > 90 % compared to classic immersion gold plating. In addition, the new process, which was developed by the Japanese company Uyemura and is exclusively distributed in Europe by Umicore Electroplating, offers the possibility of depositing a significantly thicker and absolutely homogeneous gold layer than would be possible with a pure immersion process.

Analysis and bath maintenance are of the essence

In addition, the problem of nickel corrosion can be improved if the process is monitored analytically and thus maintained very precisely.

„In order to achieve a process free from nickel corrosion by means of partially reductive gold deposition, the focus should also be more on correct bath maintenance and in-process analysis of the most important active ingredients," says

Wet chemical plant at Piu-Printex: left nickel controller and plant control, right the plating process

Andreas Gross from Umicore Electroplating. „Process control is not quite as trivial as with pure immersion gold plating. We have to pay special attention to analysis, design of tank, pump, extraction etc. These are details that play a crucial role."

In particular, Umicore recommended that the user install a new type of nickel controller, closely matched to the process, to monitor the most important bath components and dosing procedures during the plating process itself. This then resulted in the conversion of the ENIG process to Umicore chemistry and process control together with the introduction of the manufacturer's ENEPIG process as an overall project. Pohanka says: „For various reasons, we thought it made sense not to run processes from several suppliers alternately in a wet-chemical plant. That way you have a single point of contact for both processes and the certainty that if you have a problem, you won't be referred to another responsibility first."

New RF materials, for example Megatron 6, offer the advantage of less nickel corrosion and better control. „We use this material, for example, to produce 5-fold pressed printed circuit boards with up to 40 layers," says Pohanka. Due to the increasing complexity and increased use of special laminates, the problem of undesirable ingredients in the process chemistry is growing. If there should be problems then, the PCB manufacturer is easily caught between the fronts of chemical suppliers and base material manufacturers. Since the plating is done at the end of the PCB manufacturing process, edges and non-plated-through holes are exposed. On these surfaces, the base material reacts with

„In order to achieve a process free from nickel corrosion by means of partially reductive gold deposition, our attention should be increasingly focussed on correct bath maintenance and in-process analysis of the most important active ingredients"

the chemistry. This increases the problems, which is why efforts were made to improve the process which used to work well. Although the constellation of base material/ chemistry is unchangeable and ingredients of the material are still dissolved out, the new process is insensitive in this respect.

It took the user a good three weeks to reach a decision. Then, at the turn of the month September/ October 2020, nickel controllers

„We are noticing a significant demand for ENEPIG ...“

and chemistry were ordered. This was followed by two weekends of video-conference-supported introductions. First, they worked together on the commissioning of the controller and the ENIG conversion. Already in the next two production weeks, this process could be used effortlessly at Piu-Printex. This was followed by the introduction of the ENEPIG process - also during one weekend. Since the end of October 2020, both processes can be used without any problems.

Umicore Electroplating and Piu-Printex were equally satisfied with the implementation. „This was one of the shortest projects we have carried out from the first contact to the production release,“ reports Andreas Gross.

Pohanka: „We are noticing a clear demand for ENEPIG - although very few customers are using the surface for what it is best suited for: gold wire bonding. Most of those who choose this coating simply want the best surface currently available for soldering as well.“ The reason for this is, of course, the product range: for particularly demanding and high-quality assemblies.

New coating systems for high-frequency technology (RF)

Due to their higher resistivity, even the thin layers of nickel and palladium can interfere with the signals of high-frequency technology. To deal with these problems, there are several new developments for nickel-free coating systems, including the so-called Direct Immersion Gold (DIG) system. A gold layer that is applied directly to the copper. The typical gold layer thickness is in the range of 0.1 to 0.3 µm.

In addition to the advantage of RF suitability, the DIG surface has the greatest potential for fine-pitch applications with very narrow conductor and pad pitches due to its low lateral expansion of well under one micron compared to ENIG and ENEPIG coatings, where the nickel is typically applied to the copper conductors in the range of 5 µm.

To complement the process selection for its customers in these technology areas, Piu-Printex is aiming to introduce Umicore‘s final finish as the next step. *-vti-*

www.piu-printex.at, https://ep.umicore.com/