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MACFEST

ENIPIG Surface Finishes for Electronics

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Summary

Electroless coatings have found widespread appeal due to their simplicity of use. However, they have problems with plating bath breakdown and maintenance of bath chemistry because of their requirement for a reducing agent. Here we detail an immersion palladium plating bath for use in the generation of an electroless nickel, immersion palladium, immersion gold (ENIPIG) PCB surface finish as a replacement for the currently used electroless one.

Aims

The development of an immersion palladium plating bath for use in an electroless nickel, immersion palladium, immersion gold (ENIPIG) printed circuit board surface finish.

Introduction

Electroless coatings are ones where a metal is deposited from a solution containing both metal salt and reducing agent. The plating mechanism progresses by that described in ***Figure 1***.

1) *Adsorption of reducing agent onto substrate surface*
2) *Reaction of metal cation with adsorbed reducing agent*
3) *Reaction continues until either quenched or removed from bath*

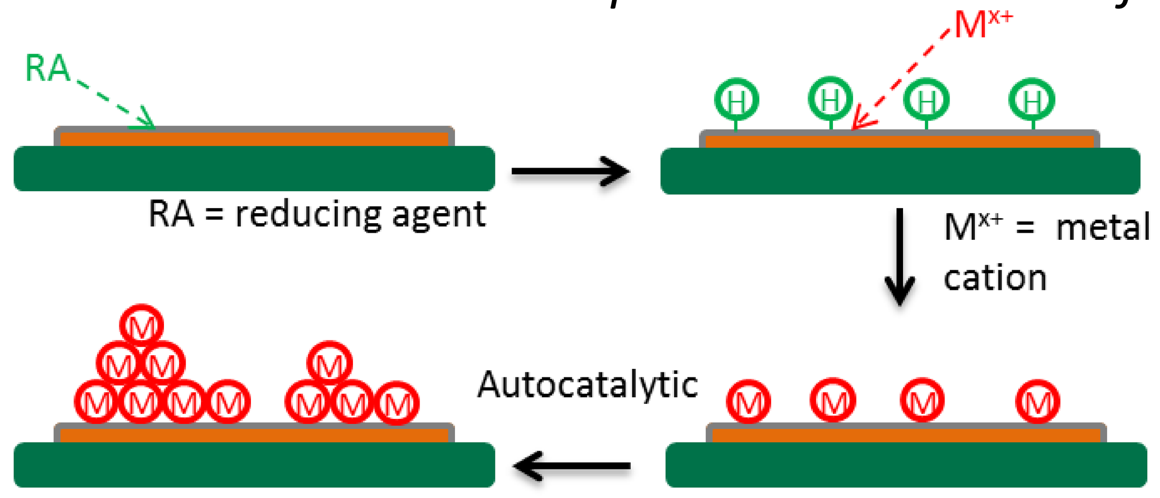

***Figure 1**: Schematic of autocatalytic electroless plating*

As no expensive electrodeposition equipment and no design modifications are required electroless plating is popular for thin films. In addition, no variations in the coatings are seen due to issues such as throwing power.

However, electroless plating processes also have their own problems.

1) *Plating bath breakdown as both redox components in solution*
2) *Extraneous plating*
3) *Buildup of reaction products in bath*

Immersion coatings are similar to electroless ones in that there is no requirement for an electrolytic setup. However, the substrate itself acts as the reducing agent, being oxidised from the surface enabling metal deposition from solution (***Figure 2)***.

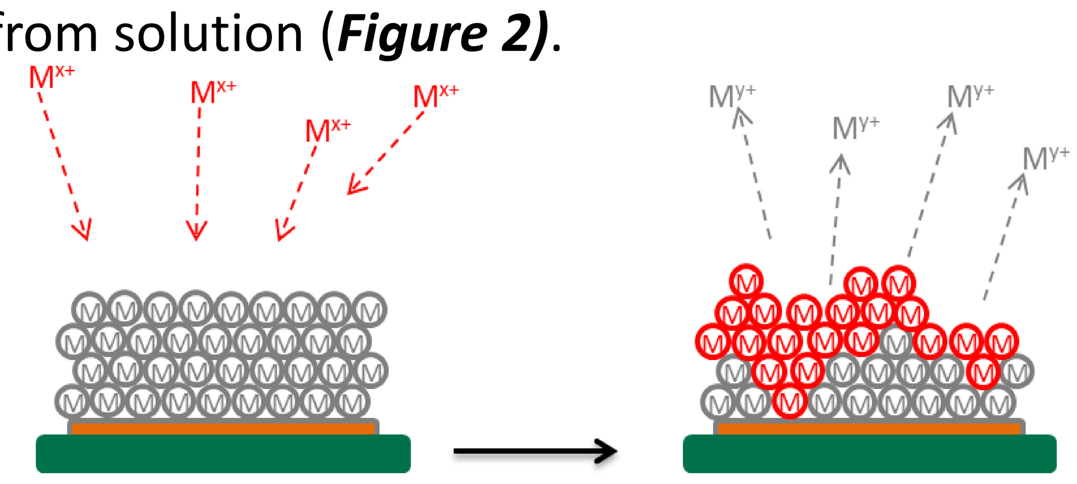

***Figure 2**: Schematic of immersion plating*

These coatings share the same benefits to those of electroless ones but also overcome many of their problems as the reducing agent is not present in the plating solution.

Electroless nickel electroless palladium immersion gold (**ENEPIG**) coatings are popular as a "universal surface finish" as they are suitable for both soldering and gold wire bonding.

However, the presence of the electroless palladium bath leads to many of the problems discussed above

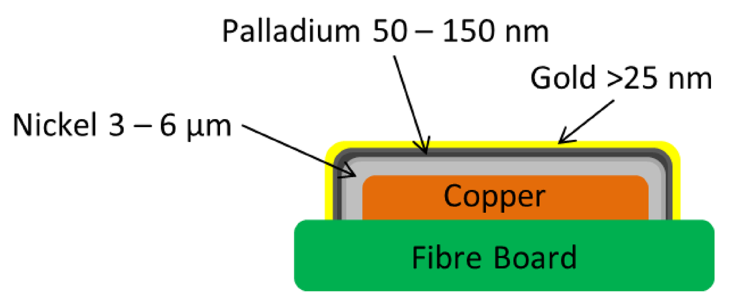

***Figure 3**: Cross section of ENEPIG coated PCB*

Results

Immersion Pd coatings were prepared onto a standardized electroless Ni (EN) substrate, deposited from Duraposit SMT 88 at 80 °C for 40 mins resulting in a coating thickness of approximately 5.4 µm and P content of 8.4 wt%. Analysis of the SEM image in ***Figure 4 a)*** shows the nodular nature of the EN coating, with little detail seen on the nodules themselves. This is confirmed by the AFM image in ***Figure 4 b)***.

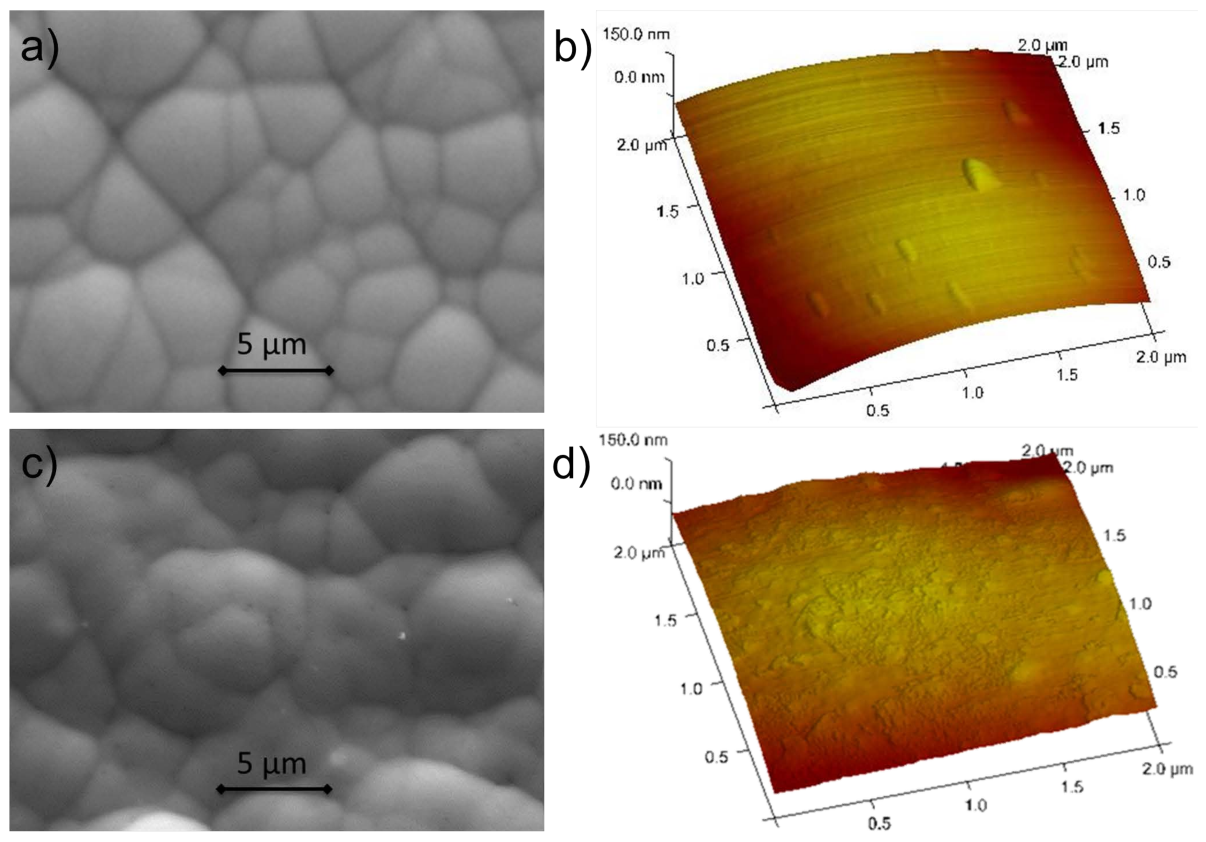

***Figure 4**: SEM and AFM images of a) & b) electroless nickel and c) and d) immersion palladium on electroless nickel*

Once the EN coated substrate had been passed through the immersion Pd plating bath at 80 °C for 20 mins the nodule boundaries can be seen much less clearly (***Figure 4 d)***, indicating a coating across the surface, confirmed by EDX showing 11.7 wt% Pd. AFM shows a slight roughening compared to the EN substrate, illustrating the Pd deposit is uniform with a fine grain size.

The immersion Pd coatings were subsequently placed in an immersion gold bath as the final step of the ENIPIG preparation. This produced a coating that visually had a uniform, bright appearance. When viewed under an optical microscope the electroless Ni nodule structure can still be seen with a gold coloured coating covering it.

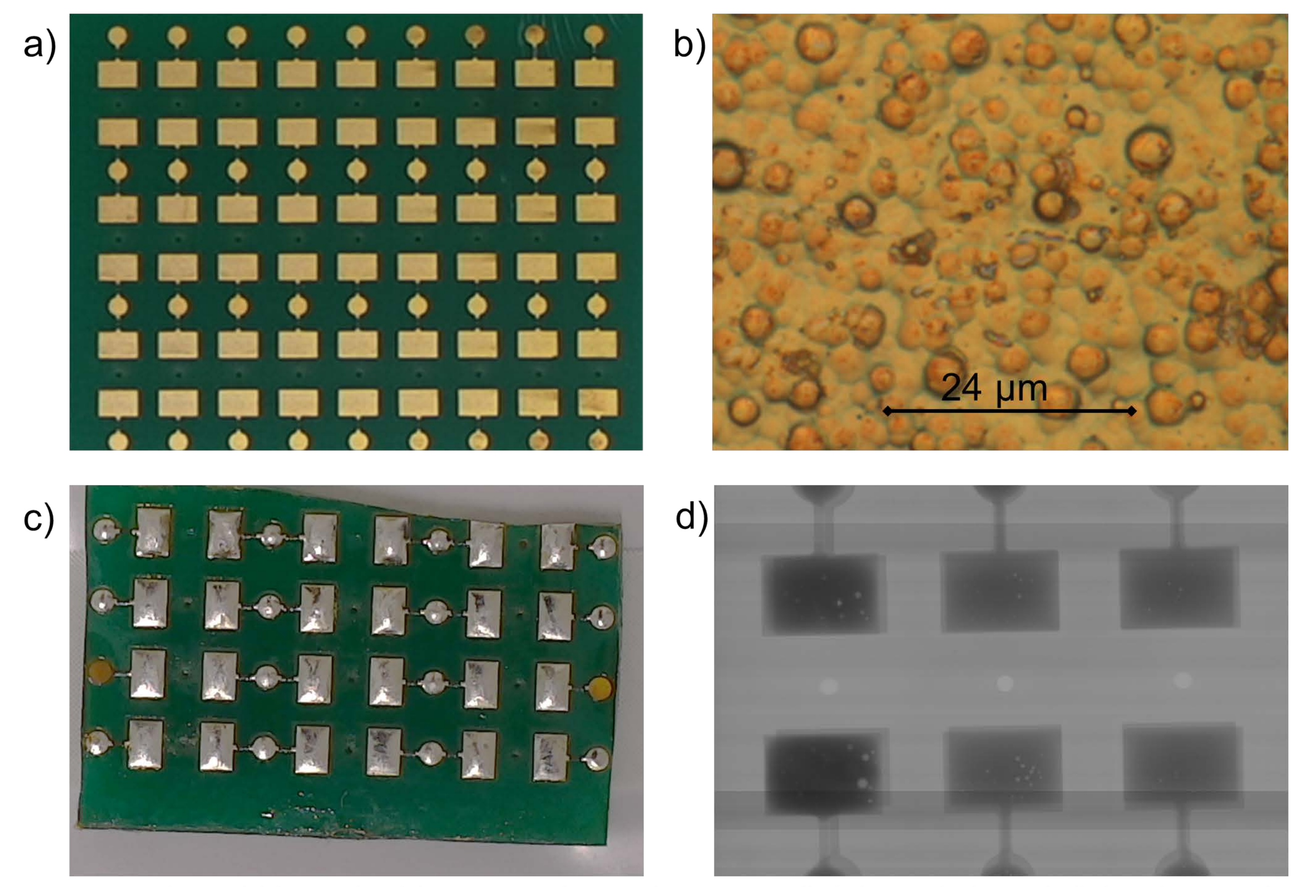

***Figure 5**: a) and b) Optical images of novel ENIPIG finish and c) and d) having undergone rotary solder wetting trials optical and x-ray image of soldered surface*

Solder wetting trials showed that the surface was highly solderable with excellent uptake of solder across the surface of the PCB. X-ray microscope analysis showed minimal voiding.

Conclusions

A method has been demonstrated for the immersion palladium coating of electroless nickel. SEM and EDX analysis shows that a uniform, thin film coating has been deposited and this has been used for subsequent immersion gold deposition to form as ENIPIG coating of uniform surface structure. Rotary wetting trials establish that this coating is highly solderable providing similar results to those of production ENIG and ENEPIG PCBs.

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