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PLATING OF CERAMIC MICROELECTRONIC CIRCUITS

Electroless nickel-boron (Ni-B) alloys are best suited for this type of circuit. There are several types of Ni-B processes, differing slightly in deposit properties. For best soldering and wire bonding, where long shelf life before soldering is not required, low boron content alloys. 0.3-1.0% B work well. Low boron deposits have the lowest resistance (7-8 micro-ohm cm). For longer shelf life solderability and wire bonding, higher boron content processes are used (2-3%). Resistance ranges from 20-60 micro-ohm cm. For best overall solder ability, low boron poly-alloys are suggested. All of these provide diffusion and migration barriers. All are suitable for die attachment by gold silica eutectic, or epoxy adhesive bonding. In some cases nickel phosphorus deposits can be used for these purposes. Los phosphorus deposits (4% or less) can be soldered and wire bonded. Shelf life is limited therefore soldering should take place soon after plating, or an over coating of gold can be applied. Nickel phosphorus deposits above 4% P tend to crack under brazing conditions making it difficult to achieve hermetic seals. Brazing to nickel-boron results in good hermetic seals as tested by mass spectrometer methods.

ELECTROLESS NICKEL PLATING PROCESS CYCLES FOR METALLIZED CERAMIC DEVICES

Plating onto molybdenum/manganese (moly-mag)
1. Alkaline clean. Ultrasonic cleaning can be important if there is any possibility of ceramic dust on the surface or in holes.
2. Treat to remove traces of moly-mag or moly from at the ceramic surface in areas between the circuit elements. This is done with a solution of 200 g/L potassium ferricyanide and 100 g/L potassium hydroxide. This is both a removal and activation step. Parts are immersed for 30-60 seconds at room temperature. Longer times or higher temperatures may result in loss of circuit dimensions. Because the ferricyanide solution is activating, it may be used again after glass removal, 10-20 seconds
3. Rinse for 1 minute with DI water.
4. Immerse in hot KOH solution to remove traces of silicon (glass) from the surface of the moly-mag. Use 100 g/l KOH at 100C (212F) to boiling for 10-15 minutes. The time is dependent on the amount of glass to be removed. Do not over etch as it may loosen the bond to ceramic. Too short a time will leave glass on the surface resulting in poor adhesion of the plated deposit. Ammonium bifluoride/hydrofluoric acid mixtures can also be used to etch glass. Caution must be used with either process. The extreme heat of the KOH solution is dangerous and the hazards of using fluorides are present in the room temperature fluoride process.
5. Rinse thoroughly with DI water.
6. Catalyze the surface for 30 seconds in a solution of palladium, silver, nickel salts or other catalytic material at room temperature. (Palladium is most commonly used.) To minimize the effect of an immersion deposit, use the lowest concentration that will provide an active catalytic surface. The actual optimum concentration varies with the condition of the metallization and must be determined experimentally.
7. Rinse with DI water.
8. Dip in 10% HCL for 30-45 seconds at room temperature.
9. Plate with electroless nickel-boron plating solution to a thickness of at least 2.5 micrometers. This minimum thickness is required to assure that enough nickel is left on the surface for tinning and chip joining after brazing. Some nickel diffuses into the molybdenum/manganese during brazing cycles of 454C to 850C (850F to1560F)

Plating onto tungsten metallized ceramic.
1. Alkaline clean. Ultrasonic is preferred.
2. Rinse (ultrasonic is preferred)
3. If the frit has a high glass phase, immerse in a solution of 100 g/L KOH at 100C to boiling for 15 minutes. Omit step 3 if glass content is very low or zero.
4. Rinse
5. Activate tungsten in a solution of 200 g/L potassium ferricyanide and 100 g/L KOH at room temperature to 40C for 20-
50 seconds. Too long in the solution can remove too much tungsten.
6. Rinse.
7. Acid dip in sulfamic acid or fluoride containing acid salts.
8. Rinse
9. Catalyze as in step 8 above.
10. Rinse.
11. Dip in 10% HCl, for 30 to 45 seconds.
12. Rinse
13. Electroless nickel plate.

**Electroless nickel plating onto bare ceramic (except AlN)**

It is possible to plate directly onto a ceramic surface without first "metallizing" the surface with a "painted on" or screened metal frit. Preparation for plating directly on a ceramic surface takes many forms. The basic requirements are: proper cleaning, a means of developing micro-porosity in the surface to produce maximum adhesion, a means of making the surface catalytic to an electroless plating solution, and a suitable electroless plating process.

Ideally, a slightly porous surface (where interlocking of plating in the pores with the surface deposit can occur) will produce maximum adhesion. The adhesion is comparable with the bond strength achieved by fired-on metallization coatings. The bond strength diminishes to bonds of 1 to 5 pounds pull (1 inch wide strip), as the porosity becomes less than ideal. Resin and organic and organic coatings as preparation materials have produced bond strength of from 2-15 pounds pull. Porosity in the ceramic surface can be controlled somewhat by the conditions under which the ceramic device is produced. The composition of the ceramic also plays a role in whether or not porosity of a suitable nature can be produced. Where there is a little or no porosity in the ceramic surface, it can sometimes be developed by etching in mixtures containing fluorides. Ninety seven percent alumina is an example of a ceramic that can be etched I fluorides to develop micro-porosity. Alumina cannot be etched effectively to develop micro-porosity suitable for plating. An alternate procedure is to immerse the ceramic in a 10% solution of KOH followed, by heat treating at 450C for 10 minutes.

**PLATING ONTO ALUMINA CERAMIC**

1. Alkaline clean to remove fingerprints and other soils. Ultrasonic energy aids cleaning and helps remove ceramic fines entrapped in the pores.
2. Rinse (ultrasonic is preferred)
3. Etch in a fluoride-containing solution such as ammonium bifluoride 60-120 g/L or hydrofluoric acid or a mixture of the two, for 2-20 minutes depending on the nature of the ceramic. The addition of 100 g/L NaCl can enhance the adhesion of the subsequent deposit.2 (see also above for KOH etching using heat treating)
4. Rinse (ultrasonic is preferred)
5. Sensitize in a dilute solution of stannous chloride (10 g/L plus 10 ml/L HCl) 1 to 2 minutes at room temperature.
6. Rinse in DI water
7. Catalyze in a dilute solution of palladium chloride (1 g/L plus 10 ml/L HCl) 1-2 minutes at room temperature.
8. Rinse in DI water
9. Electroless nickel plate
10. Rinse
11. Electroplate (optional)
12. Rinse and dry.

**PLATING BARIUM TITANATE CERAMIC**

1. Alkaline clean (see above method)
2. Rinse (ultrasonic)
3. Etch (see above method)
4. Rinse in DI water (ultrasonic)
5. Sensitize in stannous chloride (see above)
6. Rinse in DI water.
7. Catalyze (see above method)
8. Rinse in DI water.
9. Electroless nickel plate
10. Rinse
11. Electroplate (optional) Use copper, gold, silver or rhodium or as required
12. Rinse and dry.

Note: other ceramic materials have been plated using these processes and modification thereof. Examples or other ceramics plated are: Yttria, stabilized zirconia, lead zirconate, (acetic acid is added to the etching solutions), garnet ceramic, zirconium oxide, lithium noibate and ferrites.
PLATING ONTO BARIUM TITANATE

1. Alkaline clean (see above method)
2. Rinse (ultrasonic)
3. Etch (see above method)
4. Rinse in DI water (ultrasonic)
5. Sensitize in stannous chloride (see above)
6. Rinse in DI water.
7. Catalyze (see above method)
8. Rinse in DI water.
9. Electroless nickel plate
10. Rinse
11. Electroplate (optional) Use copper, gold, silver or rhodium or as required
12. Rinse and dry.

PLATING ONTO SILVER-FIRED FRIT

1. Mild alkaline clean.
2. Rinse in DI water
3. Nitric acid dip (10% by vol.) for 15 seconds (Alternate 30 g/L NaCN0
4. Rinse in DI water
5. Electroless nickel-boron plate. Note: if Nickel phosphorus EN is to be used, a nickel-boron strike may be required to initiate deposition.
6. Rinse in DI water
7. Electroplate (optional)
8. Rinse and dry

PLATING ONTO METALLIZED AlN (aluminum Nitride)

Note: AlN is sensitive to alkaline solutions; therefore an all acid treatment cycle is required.

1. Acid clean (mild phosphoric acid, or organic acid with a surfactant added)
2. Fluoride etch (see above)
3. Catalyze using 0.1 g/L palladium chloride + 20 ml/L HCl, 30 to 45 seconds
4. Electroless nickel plate
5. Rinse and dry.