DfR Solutions
reliability designed, reliability delivered

White Paper

Understanding the Risk of Gold Flash

By Randy Schueller and Craig Hillman

5110 Roanoke Place, Suite 101 College Park, Maryland 20740
Phone (301) 474-0607 Fax (240) 757-0053
www.DfRSolutions.com

Introduction

As the risk of depression fades and the electronics industry struggles to find its footing again, there must be due diligence in avoiding the same cost-reduction mistakes of prior generations of engineers. Examples include

Unsupported holes are just as robust as supported holes

Product qualification testing is too expensive and time consuming

We don't really need conformal coating

Can we reduce the gold thickness?

The later can be one of special concern, as the thickness of gold plating, and the quality, can play a key role in connector and interconnect reliability.

Connectors

Connectors typically come with either a tin plating or gold plating. While there are some excellent guidelines on the use of tin plating provided by Tyco[1], for certain applications gold-plated connectors are an absolute necessity. These include environments with corrosive gases, environments with the potential for micro-motion (due to temperature variation or vibration) and applications with low voltages and currents.

When gold-plated contacts are required, the connector industry tends to provide two different thicknesses: 15 microinches and 30 microinches. Both thicknesses exceed the typical industry definition of gold flash, which is less than 10 microinches. The initial motivation for the use of gold flash was to improve lubrication for palladium-plated contacts back in the 1970s. Palladium has poor wear resistance, while gold has excellent lubricity. The use of a small amount of gold provided substantial improvement in resistance to fretting corrosion. There was limited downside as the elevated nobility of palladium eliminated the need for the gold flash to provide environmental protection and the similar potentials of the two metals prevented galvanic corrosion.

[1] http://www.tycoelectronics.com/documentation/whitepapers/pdf/sncomrep.pdf

With the increasing price of gold in the 1970s and 1980s, the industry attempted to duplicate the success of thinner gold on palladium-plated contacts[2]. The standard gold thickness of 2.5 um (100 microinches) was gradually reduced until gold flash over nickel was proposed as the ultimate cost reducer. The electronics industry quickly realized that this low-price alternative had very limited application.

A study by Xerox in the late 1970s demonstrated that thin gold[3], defined as 0.38um (15 microinches) to 0.5um (20 microinches) was sufficiently reliable for limited-life products used in very well-controlled office environments (low humidity, no corrosive gases, low temperatures, and no vibration). In these environments, no chlorine or sulfur products were detected and the connectors were subjected to very limited insertion and removal cycles (< 5). Experiments to assess the potential for even thinner gold plating demonstrated unacceptable risk, as flash gold readily failed by adhesive wear after a few cycles[4]. Survival up to 20 cycles was only possible through the use of connectors with high contact forces.

Connector systems plated with flash gold have also been found to be extremely susceptible when exposed to a nominal level of corrosive gases[5]. When exposed to Class II environments in mixed flowing gas tests, gold flash over nickel contacts experience pore corrosion within 24 hours[6]. This accelerated behavior is due to the high density of pores in flash gold (see Table 1[7]) and the strong difference in potential between nickel and gold (as opposed to palladium and gold).

With the increasing use of personal computers and mobile devices in countries with elevated levels of pollutants[8], all responsible major consumer electronic OEMs avoid use flash gold in their connector systems.

---

[2] IEEE TRANSACTIONS ON COMPONENTS, HYBRIDS, AND MANUFACTURING TECHNOLOGY, VOL. CHMT-8, NO, 1, MARCH 1985 87, Survey of Contact Fretting in Electrical Connectors, MORTON ANTLER

[3] W. Reyes, R. Currence, E. F. St. Peter, J. Liao, and G. Bolger, "Performance of thin gold in the office environment," Thirteenth Annu. Connector Symp. Prof., Philadelphia, PA, Oct. 1980.

[4] IEEE TRANSACTIONS ON COMPONENTS, HYBRIDS, AND MANUFACTURING TECHNOLOGY, VOL. CHMT-4, no. 4, DECEMBER 1981 pp. 499, Factors Influencing Thin Gold Performance for Separable Connectors, WILL REYES, E. ST. PETER, GARY BOLGER, AND CHARLES H. SIE

[5] R. V. Chiarenzelli, "Air pollution effects of contact materials," Holm Conf. on Electrical Contacts, pp. 63-102, Chicago, IL, 1965

[6] IEEE TRANSACTIONS ON COMPONENTS, PACKAGING, AND MANUFACTURING TECHNOLOGY-PART A, VOL. 18, NO. 2, JUNE 1995 405, Protective Treatments for Gold-Flashed Contact Finishes with a Nickel Substrate, Henry H. Law, Joyce Sapjeta, and Edward S. Sproles Jr.

[7] IEEE TRANSACTIONS ON COMPONENTS, HYBRIDS, AND MANUFACTURING TECHNOLOGY, VOL. CHMT-4, no. 4, DECEMBER 1981 pp. 499, Factors Influencing Thin Gold Performance for Separable Connectors, WILL REYES, E. ST. PETER, GARY BOLGER, AND CHARLES H. SIE

[8]

Table 1

Thickness (microns)	Porosity (pores / cm2)
0.10 – 0.25	600 – 1000
0.38 – 0.50	15 – 100
0.75 – 1.00	1 - 5

Interconnects

An alternative location for flash gold in electronic systems is in its use as a solderability plating. Currently, the technology that uses gold flash for this purpose is palladium-plated components and as a final finish over nickel plating on printed circuit boards. This excludes immersion gold used in electroless nickel / immersion gold (ENIG) finishes on printed circuit boards.

While gold flash is typically defined as gold plating less than 10 microinches thick, this definition was derived before the onset of immersion type plating. When immersion process is truly self limiting, typically around 3 to 5 microinches, and not a combination of immersion and electroless, the porosity of the resulting gold layer can be the equivalent to far thicker standard gold platings. Immersion therefore eliminates a number of issues found with gold flash.

The use of gold flash has primarily been beneficial in the case of palladium-plated components. The relatively thin layer has been shown to improve solderability without any reduction in storage times. This corresponds to the relatively positive experiences of gold over palladium in connector systems. The benefits of gold flash, instead of immersion gold, over nickel on PCBs has been less clear cut. When the gold flash is too thin, as small as 0.05 um (2 microinches), an extensive amount of nickel can diffuse through the gold or be exposed through porosity. This can create some initial solderability problems[9] and greatly limit storage times. Flash is also poorly controlled compared to immersion process, which result in an excess of gold in certain areas of the board, increasing the risk of gold embrittlement.

[9] Solderability of flash gold surface finish, Yuming Wang; Mingzhi Dong; Jian Cai; Electronic Packaging Technology & High Density Packaging, 2009. ICEPT-HDP '09. Page(s): 152 - 156

Conclusion

Except for toys and other very limited-life (<6 months) products produced in very high volumes, flash gold should be avoided unless it is plated over another noble metal (such as palladium).

Disclaimer

5110 Roanoke Place, Suite 101 College Park, Maryland 20740
Phone (301) 474-0607 Fax (240) 757-0053
www.DfRSolutions.com