Dr. Joseph A. Abys • EC&S
236 Richmond Valley Road • Staten Island, NY 10309 • 718/317-4490

The Effect of Base Metal Impurities on the Solderability & Wirebonding of Semiconductor Leadframes

Introduction

Palladium surface finishes have been increasingly applied to semiconductor leadframes (Fig. 1). The superior functionality and lower total cost of palladium pre-plated leadframes (Pd PPFs), because of process simplification and the positive environmental impact of replacing tin-lead solder, have provided the impetus for this technological change.

The technology utilizes high-speed nickel and palladium plating (Pd/Ni) of the entire leadframe surface to replace the standard selective silver plating for die attach and wirebonding, and solder plating of the external leads for solderability. The latter is usually applied after package assembly (Fig. 1).

The Pd thickness is ~0.1 µm and can be Au-flashed (GFPdNi) to enhance solderability and wetting speed. It is expected that the Pd PPFs will meet the following criteria:

Solderability

Coverage/Dip-and-Look = > 95%
Wetting Speed = < 1 sec

Wirebonding

Pull Force = 7g ± 10%

Problem

An electronic device manufacturer requested Au-flashed Pd/Ni on Cu leadframes with “reduced” Pd and Au thickness as a cost reduction. The plated leadframe must exhibit excellent solderability and wirebonding.

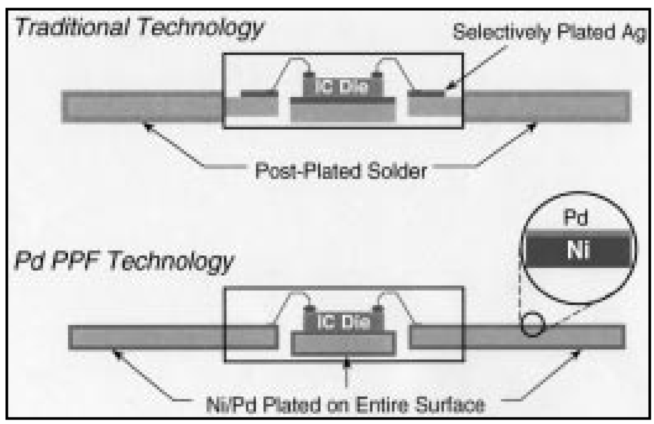


Fig. 1—Schematic cross sections of the leadframes plated with silver/solder or nickel/palladium, after die attachment, wirebonding and encapsulation, & before trimming & forming.

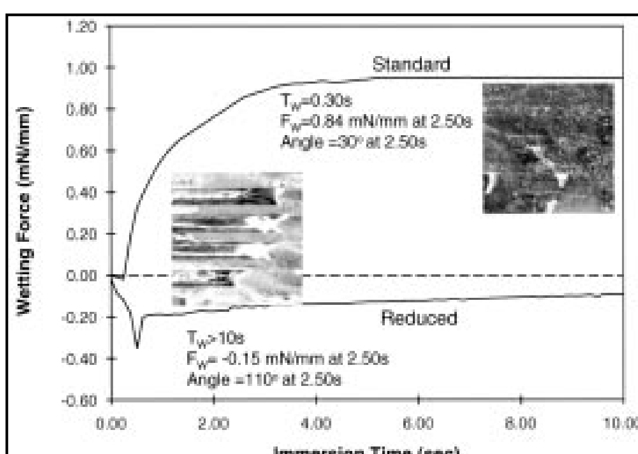


Fig. 2—Results of Dip-and-Look & Wetting Balance tests.

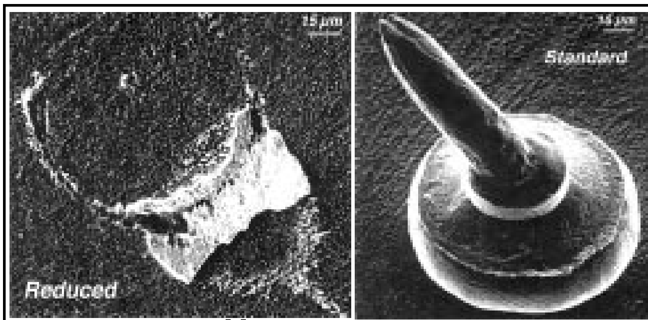
Analysis

The following analyses were undertaken to ascertain the feasibility of the customer’s request:

- Solderability tests: Dip-and-Look & Wetting Balance
- Wirebonding & Pull tests
- Auger Electron Spectroscopy (AES)—surface analysis

Leadframe samples with standard and reduced thickness of GFPd/Ni were prepared as follows:

- Standard thickness: 0.006 µm Au/ 0.10 µm Pd/1.0 µm Ni/ 150 µm Cu substrate
- Reduced thickness: 0.003 µm Au/ 0.05 µm Pd/ 0.5 µm Ni/ 150 µm Cu substrate



Unacceptable **Acceptable**

Fig. 3—Wirebonding/Pull Strength test results.

Pull Force (g)	Reduced	Standard	Requirement
Mean	5.26	7.35	≥ 7.00
Standard Dev.	1.82	0.67	≤ 10% of Mean
Minimum	1.15	5.37	≥ 5.00

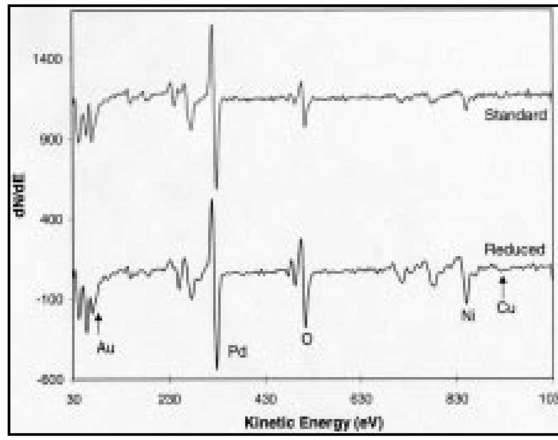


Fig. 4—Auger Electron Spectra.

Solderability results shown in Fig. 2 demonstrate the superior performance of the standard samples that exhibit wetting speeds of <1 sec, and significantly higher wetting force of 0.84 mN/mm. The reduced thickness samples, on the other hand, show a wetting speed of >10 sec and a negative wetting force of -0.15 mN/mm at a 2.50-sec time interval.

Wirebonding results are exhibited in the table and Fig. 3, and demonstrate that standard samples outperform the reduced thickness samples.

The results indicate that the reduced thickness of GFPd is unacceptable compared to the required criteria.

Surface analysis performed via Auger Electron Spectroscopy (Fig. 4) demonstrates higher concentration of Ni, Cu and O on the surface of the leadframe with the reduced thickness of Au and Pd.

The limited thickness promotes significant interdiffusion and formation of base metal oxides, which are deleterious for solderability and wirebonding.

Solution/Conclusion

A sufficient thickness of Pd and Ni finishes as specified in the "standard" is required to minimize surface oxidation and ensure solderability and wirebonding performance. P&SF