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Ion Chromatography as a Process Control Tool In Semiconductor Leadframe Manufacturing

Semiconductor packaging places great demands on the cleanliness of the environment to which the surfaces of electronic component materials are exposed. Leadframes, the building blocks of many of these packages (Fig. 1), encompass precious metal electroplating as an essential step in the manufacturing process, thereby presenting a notable challenge in this regard. Ultra-trace levels of surface contaminants such as electroplating salts can adversely effect wirebonding and solderability. Surface analytical techniques (e.g. Scanning Auger Spectroscopy, AES) have been used for failure-mode analysis to detect surface contamination.

Surface analysis is limited, however, by the expense of the equipment, difficulty of the analysis and microscopic size of the area examined. Alternatively, ion chromatography is an excellent tool for the detection of water-soluble surface contaminants. Nanogram quantities of ions per linear foot of "reel-to-reel" plated parts can be analyzed with relative ease for a fraction of the cost of surface analytical techniques.

The technique also provides the identity of the surface contaminants which is quite useful for determining the source of contamination.

Problem

A major electronics component manufacturer had been experiencing random wirebonding failures on palladium plated leadframes. Failure mode analysis via AES pointed toward potassium salt contamination, Fig. 2.

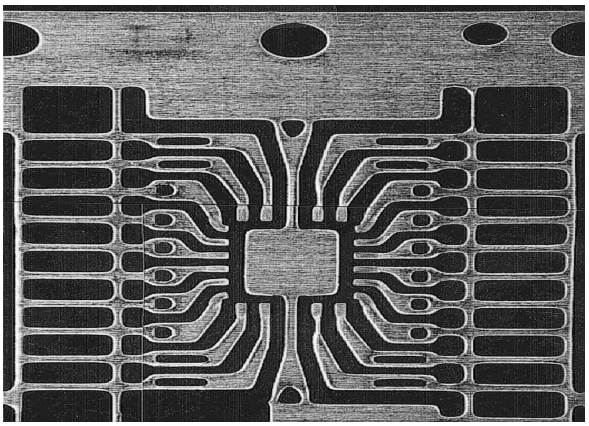

Fig. 1

The source of surface contamination was identified as "dried" salts from the palladium plating solution which were not properly rinsed in the post-plate cascade rinsing step. The job shop plater was able to improve this process but had difficulty in establishing reliable process control satisfactory to their customer.

Analysis

A leaching test was designed based on Western Electric Specification MS 17000, section 1236, which describes a conductivity test performed on the final rinse water of plated parts. A limit of 0.01 milligram of common cations

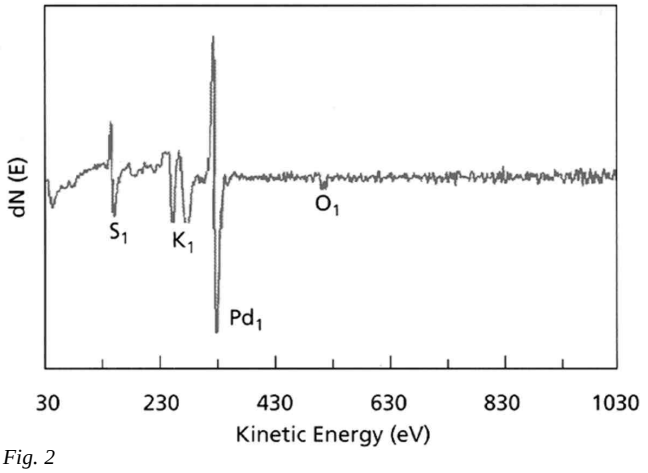

Fig. 2

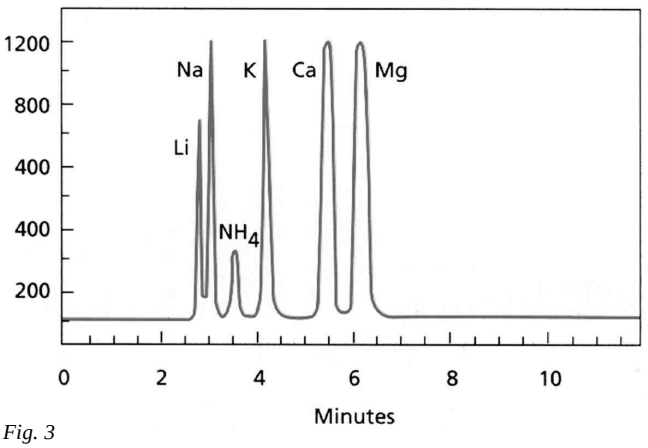

Fig. 3

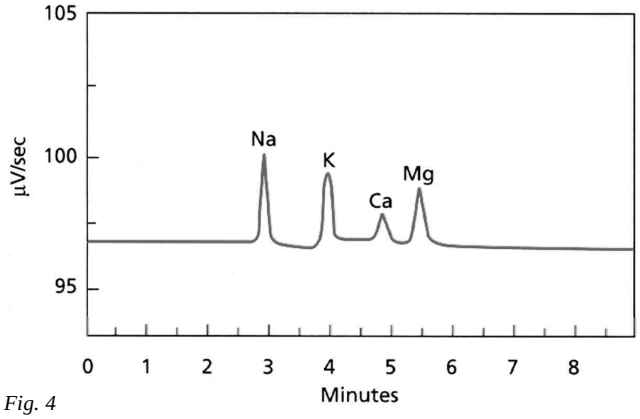

Fig. 4

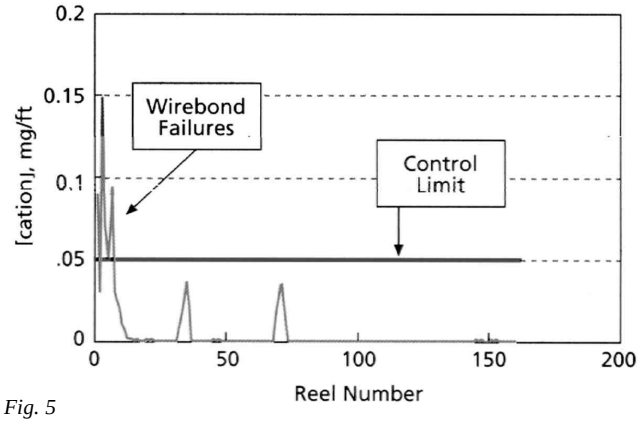

Fig. 5

(Na, NH_4, K, Ca, Mg) per linear foot was established by the component manufacturer. In the test, a linear foot of leadframe reel was leached with deionized water for 30 minutes and analyzed by cation chromatography. A common cation standard chromatogram in which the ions are present below 10 ppm is shown below, Fig. 3.

A chromatogram of a typical rinse solution which contained low levels of common cations is shown in Fig. 4.

Solution

The chromatogram above clearly shows the presence of potassium, which originated from the palladium plating bath. In addition, sodium, magnesium and calcium were detected. The origin of these ions, not previously detected by Auger Spectroscopy, was traced to poor maintenance of the ion exchange resin beds used to purify the rinse water. With the help of ion chromatography, the job shop plater was able to establish process control parameters for the cascade rinses. Furthermore, the information gained about the ion exchange resin beds dramatically improved the water quality in the entire shop and lowered their surface contamination reject rate for all plated parts. Over 160 samples were examined for salt contamination. A graph of the results, which demonstrate the difference between the "out of control" and "in control" process, is shown in Fig. 5. No further wire-bonding failures have been traced to plating salt contamination. P&SF