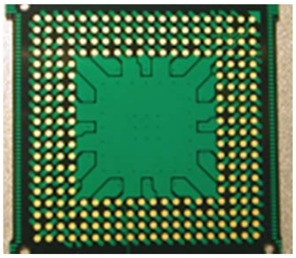
# Characterizing Electrically Isolated Bond Pads with the PHI 700Xi Scanning Auger Nanoprobe

## Introduction

Portable electronic devices are driving the use and development of space saving packaging technologies including: flip chips, chip scale packaging, wafer level packaging, etc. While the size of chips and packages is shrinking the number of I/Os per chip is increasing, causing a rapid reduction in the size of bond pads used for interconnects. This in turn is driving an increased need for nano-scale characterization of interconnect surfaces.

The surface composition of bond pads and other interconnect surfaces plays a key role in the performance and lifetime of a packaged semiconductor device. The PHI 700Xi Scanning Auger Nanoprobe can provide valuable information about the presence of surface contaminants, oxide layer thickness, and the integrity of the individual layers that form the interconnect. With sufficient history, this information can be used to provide a pass/fail evaluation for interconnect surfaces.

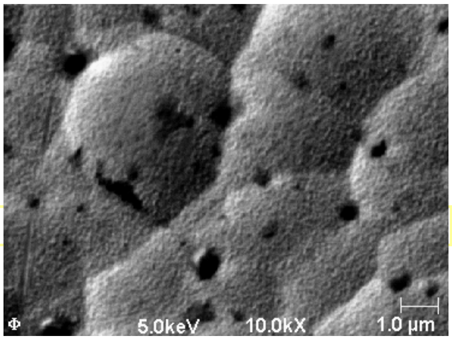


*Optical photograph of a BGA substrate*

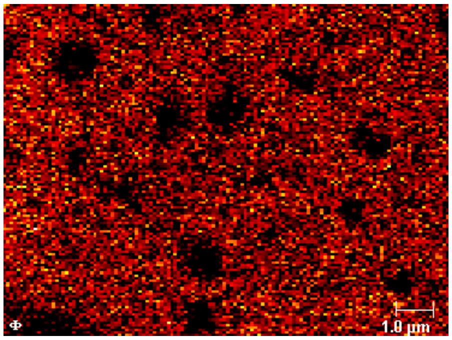
Bond pads and other interconnect features are typically composed of conductive materials, however they are frequently electrically isolated from ground in a completed package. Electrically insulating features can be very challenging to analyze by Auger Electron Spectroscopy. To overcome this challenge the PHI 700Xi is equipped with low energy ion charge neutralization capability.[1]

The Auger maps shown on this page were obtained from an electrically isolated bond pad that was part of the ball grid array substrate shown above. The instrument conditions used to provide effective charge neutralization are described on the back page of this application note.

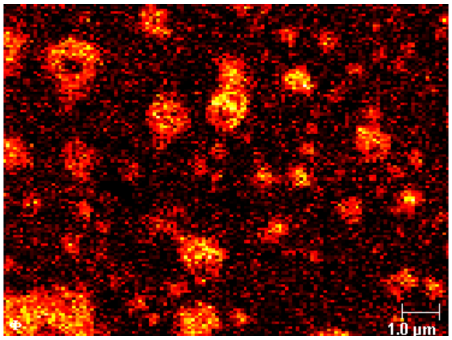
The secondary electron images and Auger maps show the presence of small Ni islands on the surface of the Au coating. The Ni islands may cause poor adhesion and lead to the formation of oxides or hydroxides on the surface that will increase the possibility of an electrical or mechanical failure at the interconnect interface.



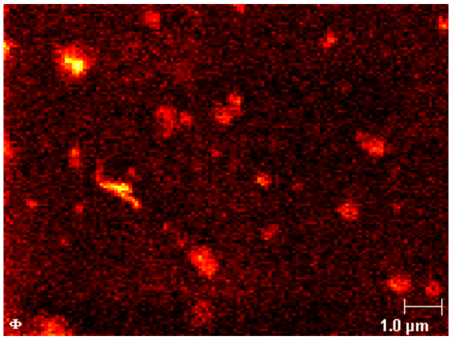

*Secondary electron image of Au bond pad surface*




*Au Auger map*




*Ni Auger map*

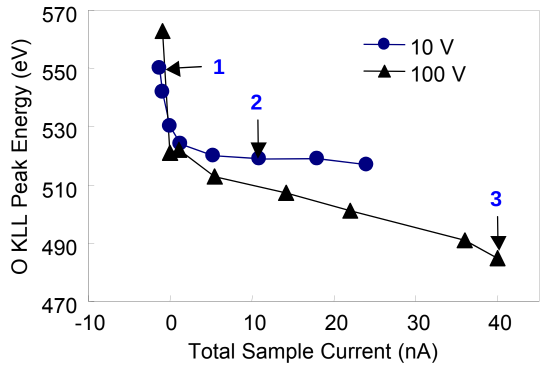



*C Auger map*

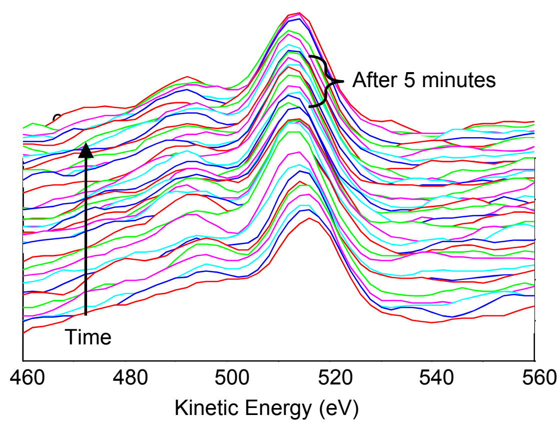
## Measurement Conditions

A Au plated bond pad approximately 1 mm in diameter was analyzed. The bond pad was electrically isolated by the package with a measured resistance greater than 500 MΩ. The secondary electron images and Auger maps were collected using a 5 keV - 5 nA electron beam. Under these conditions the electron beam diameter is approximately 45 nm. The sample was tilted so that the electron beam was at a 30° angle relative to sample normal. To determine the optimum conditions for ion beam charge neutralization, the ion beam energy was varied from 10 to 100 V and ion current was varied from 0 to 40 nA. The ion gun was located at 45° relative to the sample normal.

The adjacent graph shows the relationship between neutralizing conditions and the sample surface potential. Sample surface potential was determined by measuring the position of the oxygen KLL peak and sample current was measured on the sample holder. The graph shows that a 10 V ion beam with a few nA of current stabilizes the sample surface. At 100 V as current is increased the surface potential does not stabilize. Other tests showed that ion gun neutralizing condition #2 (10 V – 10 nA) was the most stable over an extended period of time.




*AES O KLL peak position vs. total sample current. The analyzed bond pad was isolated (>500 MΩ) from the sample holder by the package.*




*The montage display of O KLL spectra show the stability of neutralizer condition #2 over time.*

## Summary

The PHI 700Xi, with its low energy ion beam neutralization capability, extends use of Auger analysis to many applications, such as bond pads on insulating packages, that were difficult or impossible in the past.

[1] H. Iwai, H. Namba, T. Morohashi, R.E. Negri, A. Ogata, T. Hoshi and R. Oiwa, J. Surf. Anal., **5**, 161 (1999).

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