

MSi Testing & Engineering, Inc.

Your Source for Metallurgical Testing and Failure Analysis

1390 N. 25th Avenue
Melrose Park, IL 60160
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MSi Investigative Summary

SEM/EDS analysis of residue on encoder photodiode chip.

SAMPLE IDENTIFICATION

Part Description	Material	No. of Samples
Photodiode Chip from an Optical Encoder 61AY2014	Silicon-Base Plate	1
Black Cover Plate with Spots of Light-Gray Discoloration	Painted Metal Sheet	1

PERFORMED TESTING

Scanning Electron Microscopy (SEM)
Energy-Dispersive X-ray Spectroscopy (EDS)

COMMENTS

1. The performed SEM/EDS examinations were conducted to identify contaminating substances on the surfaces of the encoder photodiode chip and the cover plate. The photodiode chip was extracted using a laboratory knife. The cover plate was examined in the as-received condition.
2. The SEM micrographs of the chip and the discolorations on the cover plate were acquired using backscattered electrons and the low-pressure operating mode, due to the non-conductive nature of the samples.
3. The morphology and elemental make-up of the examined surface features were summarized on the acquired SEM micrographs and EDS spectra.
4. Evaluation of the chip fabrication processes was not within the scope of this testing. However, it should be noted that (a) the presence of the fluorine peak implied a possibility of exposure of the silicon-base chip to a hydrofluoric acid treatment; (b) the carbon peaks are most likely attributable to the polymer residue; and (c) the magnesium peak is considered to be incidental.

SUMMARY of TEST RESULTS

SEM/EDS Examinations

PHOTODIODE CHIP

1. SEM examination of the photodiode chip revealed four distinct areas of interest (see Photos 1 – 3 below and on the following page). The areas were labeled as follows:

- 1 (clean area)
- 2 (deposits)
- 3 (contact)
- 4 (dark isles on contact).

2. EDS spectra generated by the areas of interest are shown in Figures 1 – 4 below and on the following page.

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Major, minor and trace peaks on the spectra were identified on each corresponding Figure.

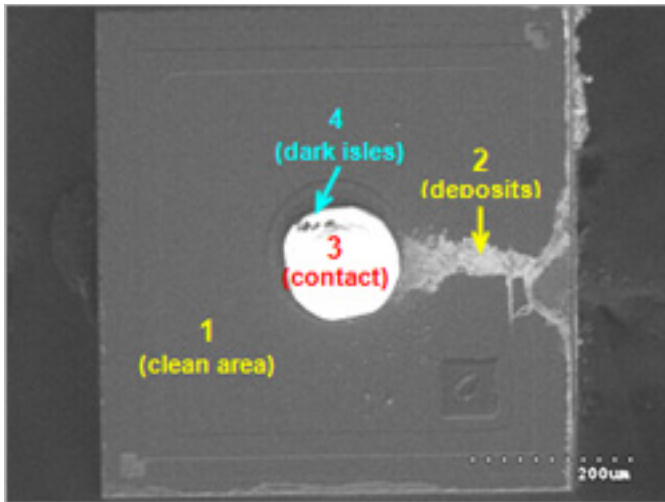


Photo 1: SEM view of the photodiode chip. Mag: 100X

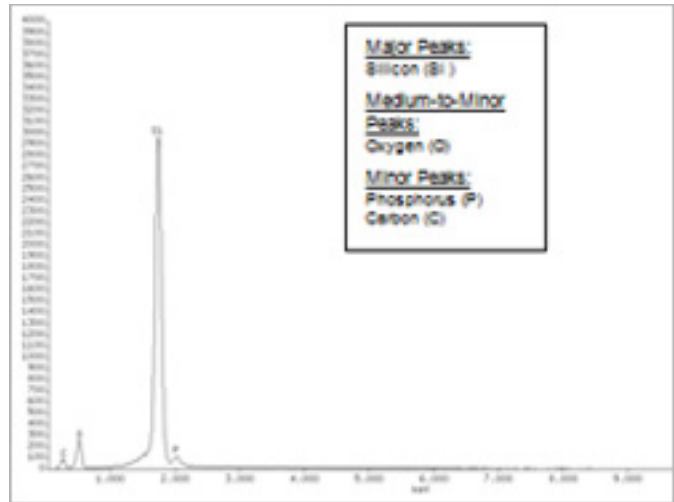


Figure 1: EDS spectrum of Area 1 (clean).

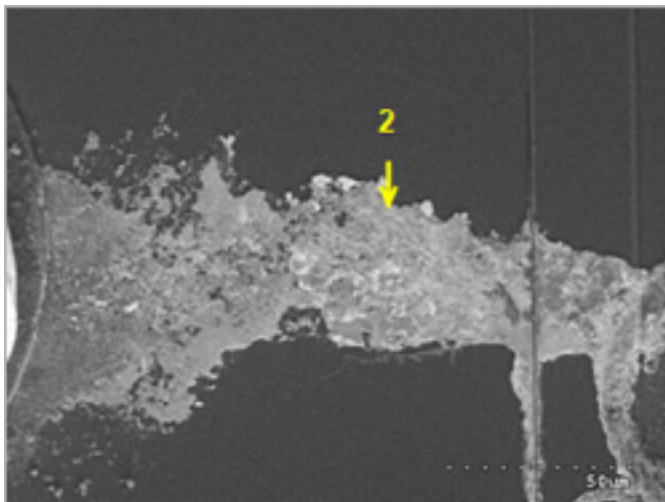


Photo 2: SEM view of Area 2 (deposits). Mag: 500X

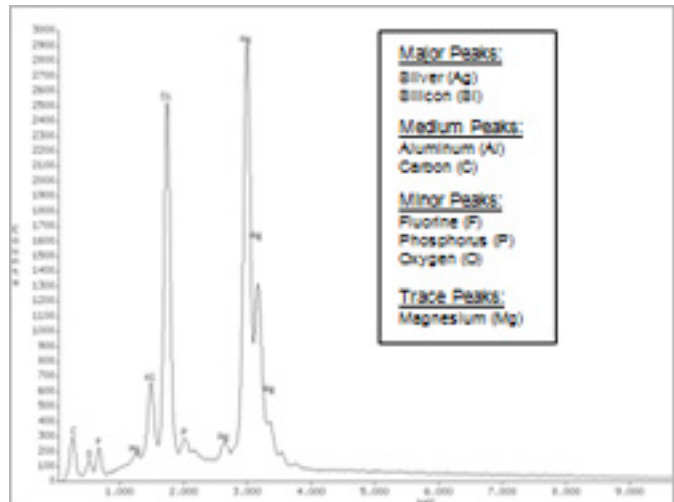


Figure 2: EDS spectrum of Area 2 (deposits).

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TESTING CERT #0510-01

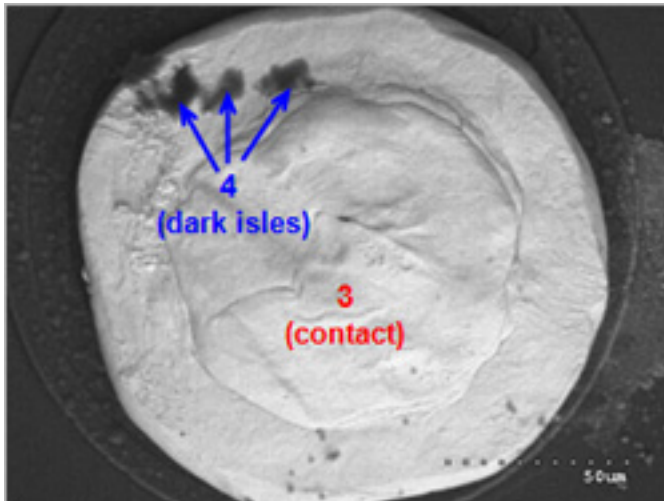


Photo 3: SEM view of Areas 3 and 4. Mag: 500X

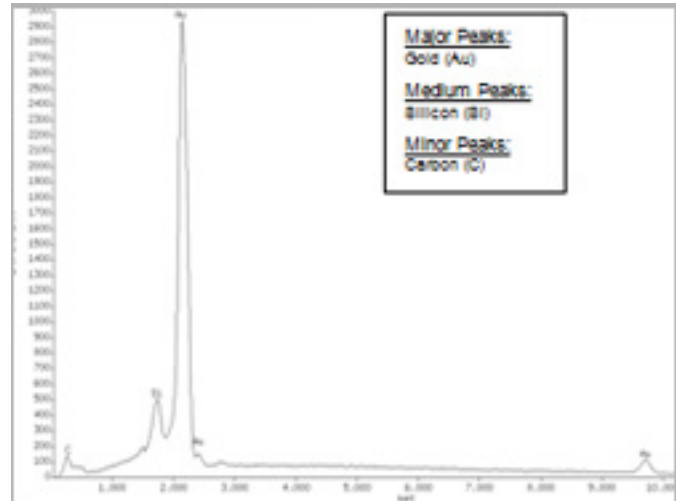


Figure 3: EDS spectrum of Area 3 (contact surface).

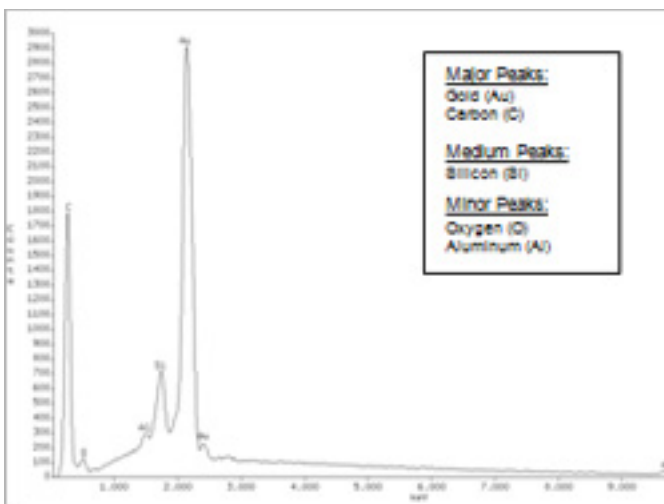


Figure 4: EDS spectrum of Area 4 (dark isles on contact).

COVER

PLATE

1. SEM examination of the cover plate surface revealed areas of discoloration forming sporadic spots on the painted surface (see Photos 4 – 5).
2. EDS spectra generated by the spots, along with a reference spectrum from the non-spotted area, are shown in Figures 5 – 7 below and on the following page. Major, minor and trace peaks on the spectra are identified on each corresponding Figure.
3. No information about the plate fabrication processes was available. However, it should be noted that the only detectable difference between the spectra generated by the discolored and non-discolored areas was the appreciably higher intensity of the carbon peak in the spotted areas. This observation implied that the discoloration

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resulted from an exposure of the plate to some unidentified organic compound (solvent, lubricant, etc.).

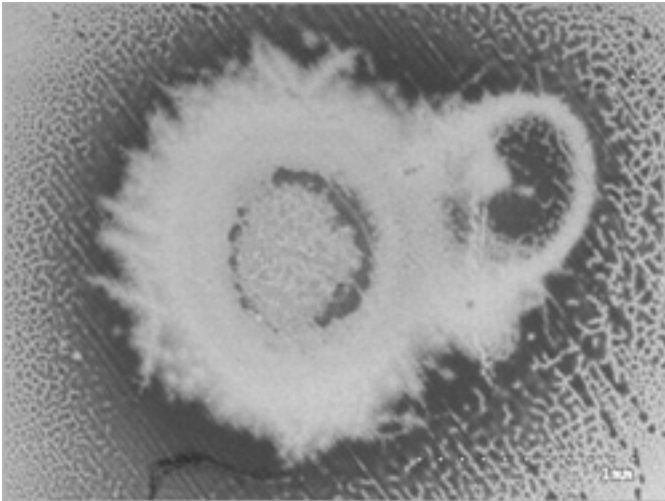


Photo 4: SEM view of Spot #1. Mag: 30X

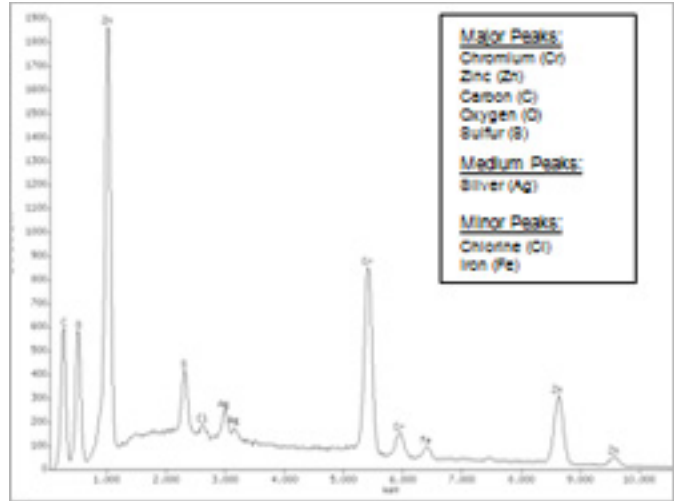


Figure 5: EDS spectrum of Spot #1.

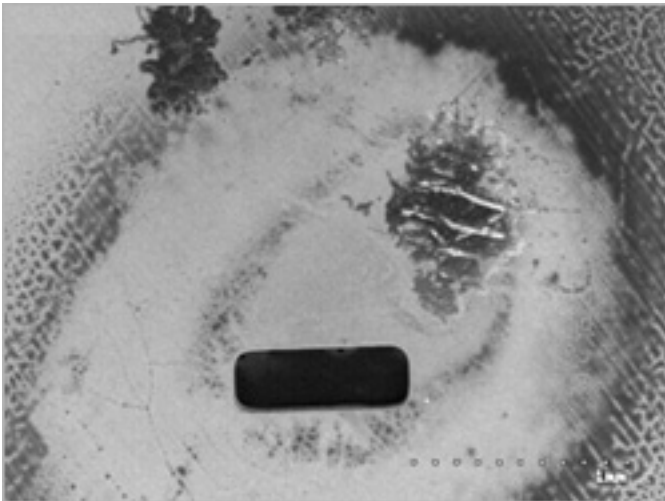


Photo 5: SEM view of Spot #2. Mag: 30X

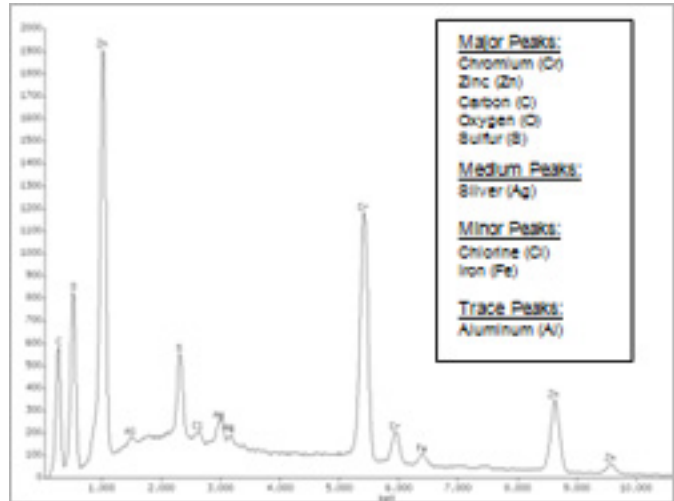


Figure 6: EDS spectrum of Spot #2.

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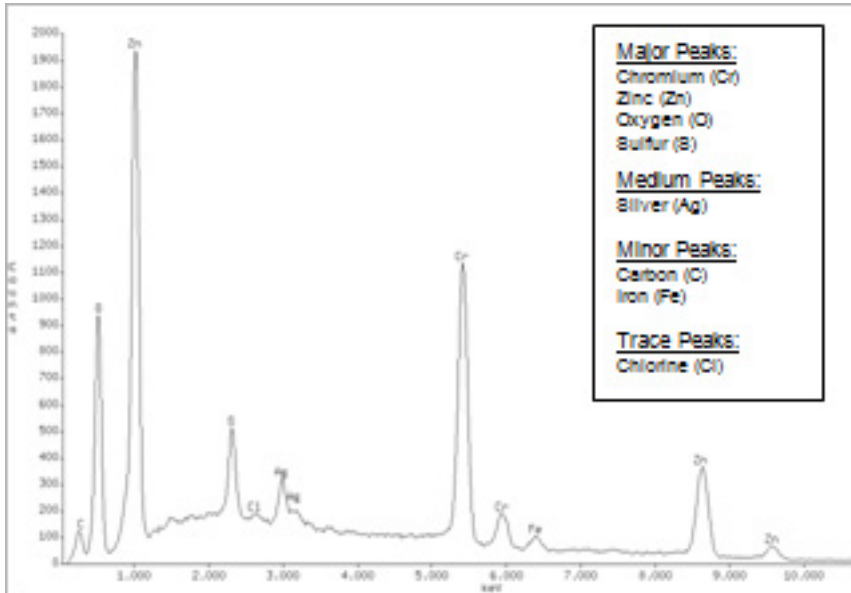


Figure 7: EDS spectrum of a random non-spotted area.