INTRODUCTION

A problem in printed circuit board (PCB) manufacturing is cracking/thinning of plating material of the through hole barrel. Unfortunately, a good number of times this anomalous condition does not become apparent until after the board has been delivered to the customer and has been populated. It is then noticed through an electrical open or a temperature sensitive intermittent connection. The intention of this paper is to inform the reader of a nondestructive, easy to perform inspection tool for PCB through hole barrels. This inspection tool is Micro-focus Radioscopy.

MICROFOCUS RADIOSCOPY

Radioscopy or realtime x-ray differs from traditional radiography in that a CRT (video display) replaces the film. Traditional radiography requires film and film processing which can be an ongoing and very expensive cost. When using a realtime x-ray system, the sample of interest is monitored on a video display. For example, if one was looking at an old style clock, he/she would actually be able to monitor the mechanical movement of the gears. Another example, if power, in the form of a square wave, were applied to the coil of a relay, you could watch the opening and closing of the contacts.

Microfocus x-ray indicates that the source of the x-ray photon is a point source where the diameter of the point source (focal spot) is less than 50um. The smaller the focal spot the better the resolution of the image. Refer to Figure 1.

---

![Image of x-ray source with small and large focal spots](image)

**FIGURE 1. MICROFOCUS X-RAY SOURCE**

1. Microfocus indicates the focal spot is less than 50um
2. Magnification = \( O_2 / O_1 = (D_1 + D_2) / D_1 \)
The American Electroplaters and Surface Finishers Society, Inc. (AESF) is an international, individual-membership, professional, technical and educational society for the advancement of electroplating and surface finishing. AESF fosters this advancement through a broad research program and comprehensive educational programs, which benefit its members and all persons involved in this widely diversified industry, as well as government agencies and the general public. AESF disseminates technical and practical information through its monthly journal, *Plating and Surface Finishing*, and through reports and other publications, meetings, symposia and conferences. Membership in AESF is open to all surface finishing professionals as well as to those who provide services, supplies, equipment, and support to the industry.

According to the guidelines established by AESF's Meetings and Symposia Committee, all authors of papers to be presented at SUWF have been requested to avoid commercialism of any kind, which includes references to company names (except in the title page of the paper), proprietary processes or equipment.

Statements of fact or opinion in these papers are those of the contributors, and the AESF assumes no responsibility for them.

All acknowledgments and references in the papers are the responsibility of the authors.

*Published by the*
American Electroplaters and Surface Finishers Society, Inc.
12644 Research Parkway • Orlando, FL 32826-3298
Telephone: 407/281-6441 • Fax: 407/281-6446

© 1992 by American Electroplaters and Surface Finishers Society, Inc. All rights reserved. Printed in the United States of America. This publication may not be reproduced, stored in a retrieval system, or transmitted in whole or part, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise without the prior written permission of AESF, 12644 Research Parkway, Orlando, FL 32826-3298.

Printed by AESF Press

SUR/FIN® is a registered trademark of the American Electroplaters and Surface Finishers Society, Inc.
SYSTEM DESCRIPTION

Realtime microfocus x-ray provides instant feedback to the operator. One simply places the board in a holder located on a moveable stage, closes the cabinet door, activates the x-ray source, and begins the examination by looking at the x-ray image on the video display. No sample preparation is required.

The x-ray image is produced by subjecting the board to x-ray photons. Different materials in the board absorb different amounts of radiation thus casting a shadow onto the focal plane. An analogy to this is shining a flash light at your hand and casting a shadow onto the wall. The difference between radiography and realtime, is in radiography, the focal plane is the film, and in realtime, the focal plane is an x-ray image intensifier. The image intensifier converts x-ray photons into visible light photons. Different magnitudes of flux will cause a different grey level of light to be emitted from the intensifier. The subsequent output of the intensifier is captured by a camera and transmitted to the video display. Refer to Figure 2.

EXAMINATION

As stated above, the examination begins by placing the board in a suitable fixture on the moveable stage and subjecting
e board to x-ray photons. Positioning the board is readily done if the stage of the x-ray stem has multiple axes of manipulation, including tilt and rotate. The stage is controlled in either manual mode (joysticks) or automatic mode (computer numeric control CNC).

For best viewing of the barrel, the board is positioned at an angle with respect to the focal spot. When the board is tilted in this manner, a two dimensional image with a three dimensional impression of the board is observed. With this depth of field, one is able to count the layers of the board. Also with this view, the inner wall of the barrel can be observed. In order to view all interested barrels, the x/y stage is simply maneuvered, in either manual or automatic mode. A large number of sites can be scrutinized very quickly. Refer to Photographs 1, 2, and 3.

When viewing a positive image as in Photographs 1, 2, and 3, voids will appear as light areas. These could range in size from inconsequential to encompassing the entire wall in the form of a ring. When this occurs, layers on either side of the ring are electrically isolated. The operator can also inspect for uniformity of the plating thickness. Variant thicknesses will show up as contrast differences. Areas of a barrel wall which appear darker have plating material which is thicker than the surrounding contrast areas. Another condition which might be noticed is large build-up of plating material. This area would be very dark and would have dimensions. Due to the small focal spot size and high magnification, cracks in the plating material could also be observed. Virtually any substantial inconsistencies could be noted and documented.

**IMAGE QUALITY**

Resolution of the image is dependent on several factors. One of these factors is the focal spot size. Features smaller than the focal spot size cannot be resolved. For instance, if the system has a 5um focal spot size, the features to be imaged have to be greater than 5um. Another factor is geometric magnification. Magnification is achieved by bringing the board closer to the focal point. If a feature has a dimension of 10um and is magnified 100X then the corresponding image of the feature is 1,000um (1mm) which can easily be resolved by the human eye. A third important factor is contrast. When inspecting for plating thickness differences, an operator would be looking for a contrast or a grey level difference. The contrast ability of a system is dependent on many factors but an average system can show a 5% density (thickness) difference or better. The closed circuit TV
(CCTV) is another important factor in the final image quality. Most microfocus radioscopic systems are able to resolve substantial flaws but only the systems with small focal spots and high geometric magnification will be able to resolve the smaller flaws.

CONCLUSION

In conclusion, realtime microfocus x-ray is a very useful tool in determining barrel plating integrity. The instantaneous feedback to quality control can better help control the manufacturing process. The tool does not require highly trained personnel, is safe, and is not labor intensive.

PHOTO 2
A close-up view of Photo 1

PHOTO 3
A positive image of the barrel showing a large void towards the top (lighter area).