

PROCEEDINGS
of the 1986
INTERNATIONAL
SYMPOSIUM ON
MICROELECTRONICS

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FOR HYBRID MICROELECTRONICS**

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by the
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and the
Society Staff**

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**International Society for Hybrid Microelectronics
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Introduction to the 1986 International Microelectronics Symposium

The theme for this year's symposium "The Ever Expanding World of Hybrid Microelectronics" is certainly exemplified by the technical spectrum covered by this year's papers. Every effort has been made by the Selection Committee to ensure that the papers disclose new information to supplement existing technology.

The international character of this symposium has been retained with papers from Asia, Japan, Europe and Canada.

In sheer numbers (though this was not the only goal) this symposium sets a record with 140 papers spread over 18 sessions and three full days, and that is not counting the tutorials and short courses—all of which have been updated with reference to course content. The SMT short courses have been biased toward the reliability aspects of that technology.

The sessions on Automated Assembly/Inspection and Manufacturing/Operations present a response to the often repeated criticism that we have become a nation of inventors that cannot successfully convert such inventions into products.

Doug Bokil
Technical Program Chairman

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The International Society for Hybrid Microelectronics (ISHM) is a non-profit technical society dedicated to the advancement of microelectronics. The Society's prime objectives are to provide a forum for the dissemination of knowledge within the field of microelectronics, and to serve as a common denominator for the diverse engineering disciplines on which microelectronics is based.

ISHM encourages the exchange of information among the complementary technologies of ceramics, thin- and thick-films, semiconductor packaging, discrete semiconductor devices, and monolithic circuits. Microelectronics has developed into a distinct field of activities embracing materials, design, processing techniques and equipment, and fabrication and applications engineering. ISHM's technical meetings and publications reflect the full range of these engineering specialties.

The Society now has more than 70 chapters located throughout the United States, Western Europe, and the Far East. Its annual international symposia have been highly successful, due primarily to the excellence of their technical programs. ISHM has more than 7000 members in 24 countries throughout the world, an international headquarters to coordinate and manage its many comprehensive and diverse activities, a dynamic educational program for colleges and universities, and an active publications program.

Today, ISHM stands as a thriving and vigorous technical society, immensely proud of its distinguished reputation and totally committed to the service of its dedicated membership and the flourishing microelectronics industry.

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Presented to
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For his total dedication to ISHM and his leadership in initiating and guiding the Society in its most innovative programs in education and publications, as well as his continuing leadership in thick film hybrid and material technology.

Corporate Recognition Award

Presented to
**Electro Science Laboratories
(ESL)**

In recognition of its achievements in the areas of thick film in microelectronics and displays and its continuing active support of the Society directly and through its employees by their participation in local and national offices and their many technical presentations.

Technical Achievement Award

Presented to
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For his untiring work in Surface Mount Technology.

David K. Flattery

For his untiring work in Infrared Sintering of thick film materials.

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Presented to
Akira Ikegami

In recognition of his many contributions in microelectronic sensors.

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IN-LINE MACHINE VISION INSPECTION AND CONTROL OF THICK-FILM PRINTING

by

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Abstract

The requirements and use of machine vision systems for verification and process control of thick-film printing are discussed. A new in-line machine vision inspection system, which can inspect the printing and feed back process control information to the printer, is described. Two material handling systems are also described -- a "fixed automation" system and a "flexible automation" industrial robot; the robotic approach appears to have the greatest potential.

1.0 INTRODUCTION

1.1 Optical Inspection in Hybrid Circuit Manufacture

The first stage of hybrid circuit manufacture involves the use of thick-film and/or thin-film fabrication processes to print an electrical circuit pattern on a ceramic substrate¹. These circuits typically require multilayer printing, often involving as many as 6 to 20 consecutive printing operations to make a finished substrate.

Since these multilayer circuits can not be tested electrically until most or all of the circuit layers have been printed, optical inspection is used to verify proper printing of lower-layer circuitry before the upper layers are superimposed. This procedure has a significant advantage because it allows defects to be detected -- and repaired if possible -- before the added expense of the many top layers is added to the substrate, which would then have to be scrapped at final electrical test (when it is too late to repair the defective lower layers).

If electrical testing is not done, or is not feasible until all the circuit devices are added, even greater waste will result by attaching circuit devices to a substrate which has a printing defect in a non-repairable lower layer.

Finally, optical inspection can detect potential or incipient defects that can not be found by ordinary electrical testing. Such defects as near-shorts and partial opens may pass initial electrical test, but fail in the field when "real-world" high current or voltage surges are introduced into the circuit!

1.2 Why Machine Vision?

Human visual inspection has certain advantages over machine vision systems, such as the ability to view objects with greater understanding. However, the

advantages of traditional human optical inspection techniques are far outweighed by the disadvantages. Everything that is inspected by a human being is subjected to the individual's mental processes. This is where such strictly human qualities, such as fatigue and lapses in concentration, will affect the inspection decision (pass or fail).

Several objective studies in production situations have shown that, over the long term, human operators will miss from 10% to 40% of all circuit defects! This makes reliable quality control nearly impossible in real-world production situations!

With increasingly faster production lines and the introduction of denser, more complex circuits, the inadequacies of human visual inspection techniques becomes more serious. Today's quality and production speed requirements demand more sophisticated inspection methods. Automatic optical inspection techniques can meet these needs while offering many important benefits to hybrid manufacturers -- such as increased throughput,² inspection reliability and consistency.

1.3 Why In-Line Inspection?

Having determined the superiority of machine vision for inspecting hybrid circuitry during the substrate printing cycle, the next issue to be addressed is whether to utilize machine vision in an in-line or off-line capacity. Machine vision systems can be used effectively in either mode. However, there are significant benefits to employing such a system in-line as opposed to off-line. Generally, in-line inspection systems offer greater reliability and allow for more effective process control. Circuitry defects can occur at any time and for many different reasons; in-line inspection enables the manufacturer to detect defects early. This eliminates the cost of printing thousands of copies of a defective circuit.