TO-118 • PT 1.2837
Peter Grünberg Institute
Quantum Nanoscience (PGI-3)

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Non-Destructive Electrical Characterization of Integrated Circuits for the Semiconductor Industry

Technology Description

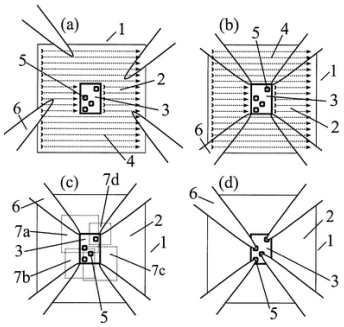
The invention describes a method for electrical examination of electronic components in an integrated circuit using nanoprobers. These probers are used in the semiconductor industry and research institutes to characterize integrated circuits electrically for failure analysis and process optimization. Two types of nanoprobers, scanning electron microscope-based (SEM) and atomic force microscope-based (AFM) nanoprobers, are commonly used and each type has its advantages and disadvantages. SEM-based nanoprobes offer fast imaging, zoom capabilities, and avoidance of lateral leakage currents. AFM-based nanoprobes allow for contact with the sample under force control and detection of sensitive electrical signals during imaging. Our approach aims to overcome the limitations of each method and provide a comprehensive solution for electrical characterization.

Problem

Common methods using SEM-based nanoprobers or a combination of SEM and AFM nanoprobes still pose the risk of damaging the sensitive components due to electron beam radiation. The existing techniques for avoiding radiation damage are not universally applicable, especially when the sensitive components are fully within the target area during the analysis. This results in potential damage to electronic components during imaging and hindered accurate positioning of the nanoprobes.

Solution

Our new approach overcomes the limitations of previous methods by combining SEM and AFM imaging without exposing the target area to the electron beam. Initially, imaging the non-target area with SEM and gradually approaching the nanoprobes to the target area is performed.



Subsequently, the approach of the nanoprobes to the contacts and electrical testing can be performed under AFM control without compromising the quality or integrity of the components by the electron beam radiation of the SEM. This is particularly beneficial when the contact points are fully within the target area.

IP: PCT/DE2019/000295, DE102018009623.9, WO/2020/114533, EP3891515, US20220244290

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Contact
Scientific Contact
Prof. Dr. Bert Voigtländer

Innovation Manager
Dr. Jörg Bohnemann

Keywords: Nanoprober, failure analysis, scanning electron microscopy, SEM, atomic force microscopy, AFM, quality control

More Information
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As of 10/2023

Potential Use

The technology enables the examination and quality control of electronic components in integrated circuits. It is particularly beneficial when electron beam induced degradation of the devices has to be avoided. The combined SEM and AFM imaging avoiding electron beam radiation at the target area allows for comprehensive electrical measurements, including the evaluation of functional components such as capacitors, transistors, resistors, and diodes. Additionally, conductive AFM can be employed to investigate the electrical properties of the integrated circuit. Overall, this technology offers a non-destructive and efficient solution for the electrical characterization of electronic components in the semiconductor industry.

Development Status and Next Steps

Forschungszentrum Jülich has extensive expertise in this field and holds several patents. The technology described above has already been initially verified through prototypes and is continuously being developed further. The Peter Grünberg Institute (PGI-3) – Quantum Nanoscience – already cooperates with numerous national and international companies and scientific partners. Forschungszentrum Jülich focuses on energy and cost-efficient devices, suitable for various emerging technologies. We are continuously seeking for cooperation partners and/or licensees in this and adjacent areas of research and applications.

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