Team Details

Team Name: PIXELS

SR. NO	ROLE	NAME	ACADEMIC YEAR
1	**Team Leader**	Tatikole Ashwini	2nd Year
2	Member 1	Vanisha Nadimpalli	2nd Year
3	Member 2	Yadagiri Navadeep Saran	2nd Year
4	Member 3	Ravi Tanuja	2nd Year

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Problem Statement Addressed

Edge-AI based defect classification system for semi conductor wafer/die images

- **Defect Types**: Semiconductor wafers contain multiple defect classes—shorts, opens, bridges, vias, scratches, cracks, and LER that impact product quality.
- **Current Limitation**: Manual visual inspection by human operators is time-consuming, inconsistent, and prone to human error.
- **Quality Impact**: Missed defects during inspection lead to faulty products reaching customers, causing warranty claims and brand reputation damage.
- **Industry Criticality**: Semiconductors are essential for electronics, IoT, automotive, and AI applications—quality failures have cascading effects.
- **Production Bottleneck**: Manual inspection creates delays in manufacturing workflow, reducing throughput and increasing operational costs.
- **Need for Automation**: Requires an automated, AI-powered defect detection system delivering high accuracy with real-time processing on manufacturing floors.

Idea Description -

Edge-optimized AI model automatically classifies semiconductor wafer defects in real-time.

KEY CONCEPT & APPROACH

Automated semiconductor defect classification using zero-shot learning for dataset organization followed by transfer learning on a lightweight mobile architecture with class-balancing techniques to create an edge-deployable model.

SOLUTION OVERVIEW

Developed an edge-ready semiconductor defect classifier by leveraging CLIP for automated data organization, transfer learning with MobileNetV2 to handle severe class imbalance, and ONNX conversion to deliver a 9.11 MB model achieving 69.93% accuracy with sub-100ms inference for NXP eIQ deployment.

Proposed Solution

Deep learning CNN model for automated semiconductor wafer defect detection, optimized for edge deployment with real-time inference.

We propose an Edge-AI–based defect classification system using lightweight deep learning to automatically identify wafer defect patterns from semiconductor inspection images. The solution is optimized for fast, low-memory inference suitable for edge deployment in manufacturing environments.

Dataset Plan:
Total images planned/current: 27900
No. of classes: 8
Class list: Bridges + CMP_Scratches+cracks+LER+Malformed_Vias+Opens + Clean + Other
Class balance plan: Balanced class weights (inverse frequency) to handle natural imbalance ratio of up to 18,865:24(786:1)
Train/Val/Test split: 80/10/10
Image type: Semiconductor microscopy images (SEM/AFM)
Labelling method/source: CLIP-based zero-shot classification + automated organization

Technology & Feasibility/Methodology Used

A lightweight MobileNetV2 model is trained using transfer learning on a public semiconductor wafer dataset and evaluated using accuracy, precision, recall, and a confusion matrix on the test set.

Model details:

Architecture: MobileNetV2+Custom classification Head
Training approach: Transfer learning + class-Weighted loss
Input size: 224 x 224 x 3
Model size: 9.11 MB
Framework: Training: TensorFlow/Keras
Deployment: ONNX (Edge AI - NXP eIQ compatible)

Metrics on your test split:

Accuracy: 69.93%
Precision/Recall: 85%/70%
Confusion Matrix: (image)
https://drive.google.com/file/d/1iZ8y4ObF5GhkJQMyXZHAayQpOO3evA_P/view?usp=drive_link

Artifacts & Links

GitHub Repository

https://github.com/Vanisha-18/semiconductor-defect-classification-edge-ai

Prototype / Simulation Video

https://drive.google.com/file/d/1qByS3AvmUSoQKtkTevO7nTg5aLYHIlcC/view?usp=sharing

Dataset ZIP link

https://drive.google.com/drive/folders/1uKFTmw25IH3mjKaPWMHHpKNHDYhizfzs?usp=drive_link

ONNX model link

https://drive.google.com/file/d/1o3DDbjcMov8xbpt6PkzYStKMcLOTmJl3/view?usp=drive_link

Results report link

https://docs.google.com/document/d/1GwZR1t4I2iKUrBogeYhUHgmXIFUSo5haxoOUYyzSgCo/edit?usp=sharing

Research and References

Research & References

1. https://researchdata.ntu.edu.sg/dataset.xhtml?persistentId=doi:10.21979/N9/WBLTFI
2. https://github.com/wenbihan/MIIC-IAD?tab=readme-ov-file