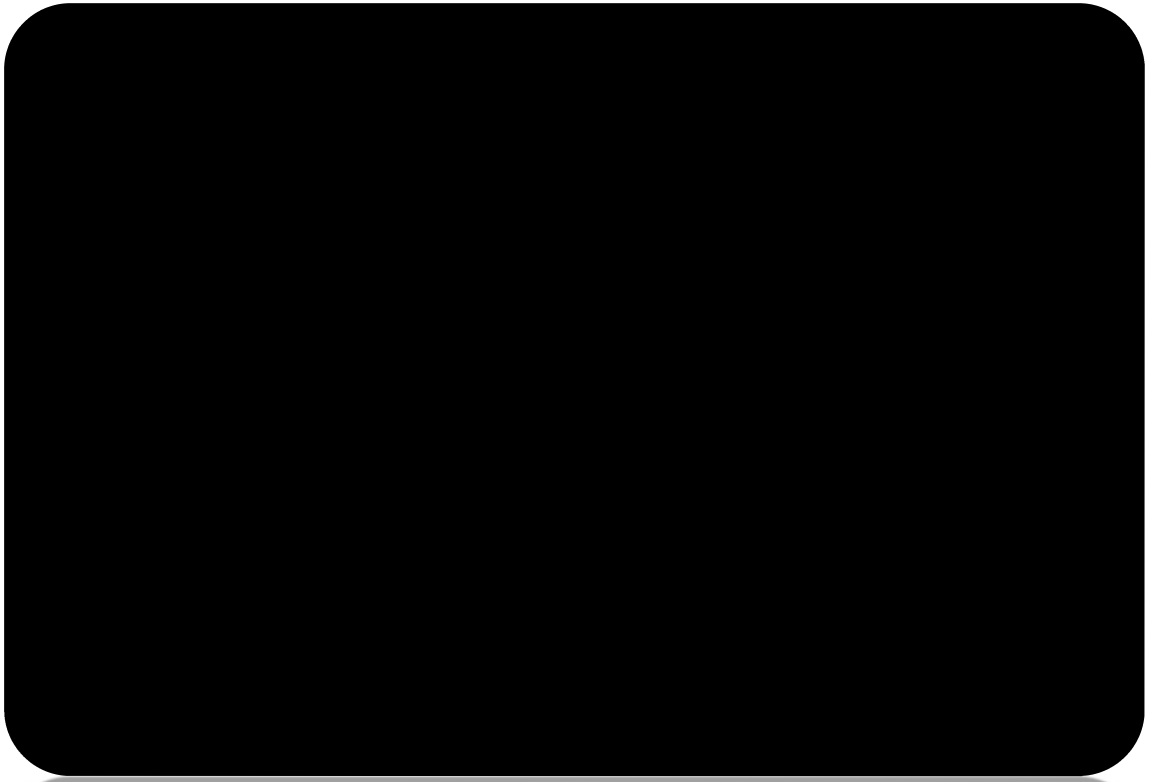
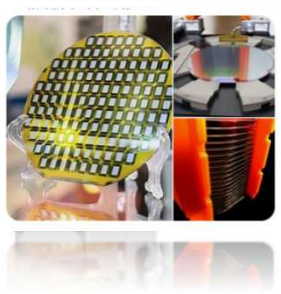
Image Restoration for Scanning Acoustic Microscopy Systems
- *Research Overview and Introduction* -

Trong Nhan Nguyen
Pukyong National University, Busan, 48513, South Korea.
Email: nguyennhan8521@gmail.com

Scanning Acoustic Microscopy - Industrial Applications



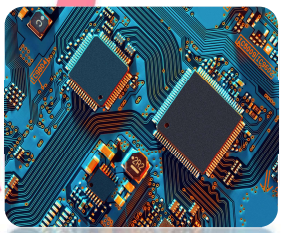
Video 1.
Introduce Scanning Acoustic Microscopy system (Ohlabs Company)



Semiconductor
- Wafer
- Flip chip
- Circuit boards



Advanced Materials
- Carbon fiber
- Battery components



Microelectronics
- Microprocessors
- CPU sample
- Display panel

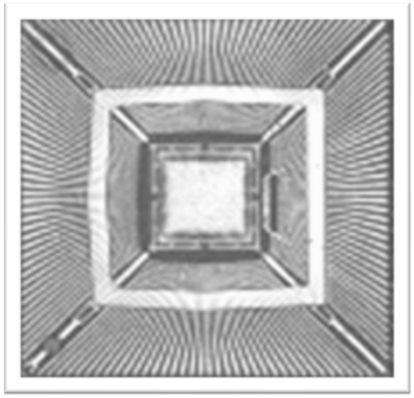


Biomedical
- Implants, bones
- Medical package defects

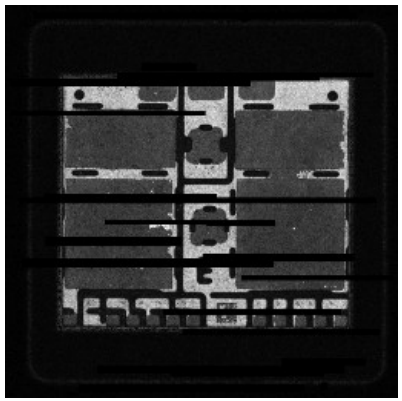
Scanning Acoustic Microscopy – Image Issues & Case Study

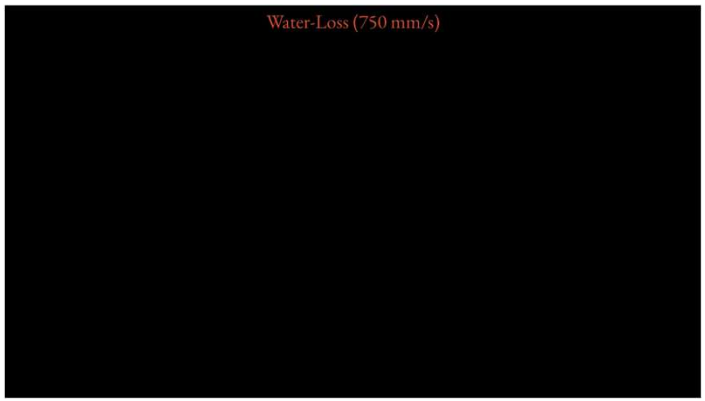
SAM Systems



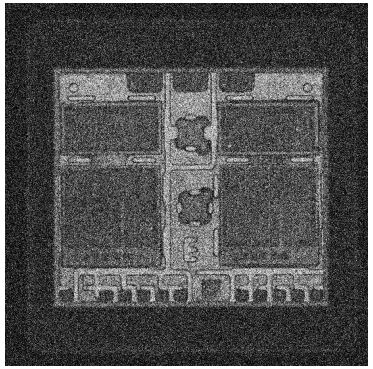


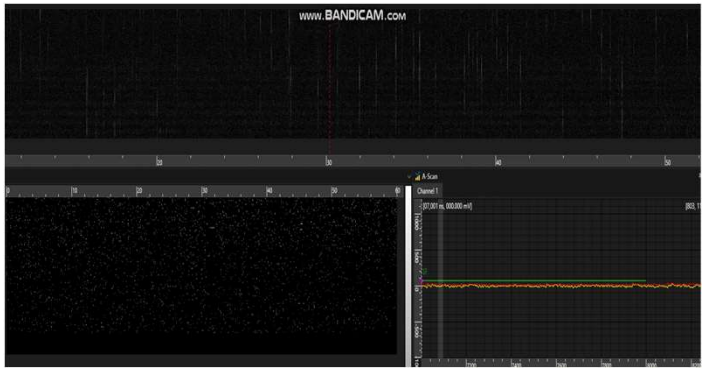
1. Low Resolution





2. Acoustic Signal Loss

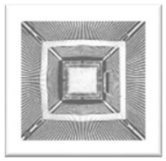


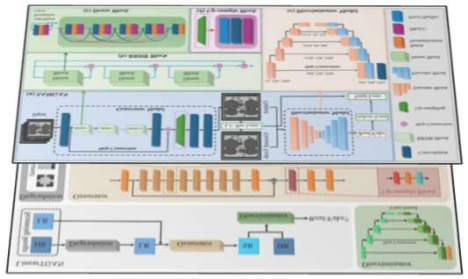


3. Noise signal

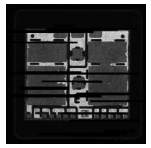
Scanning Acoustic Microscopy – Image Restoration Research

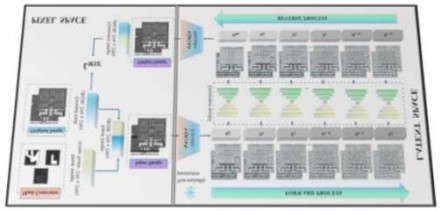
1 Super Resolution



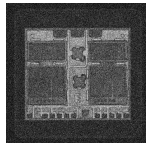


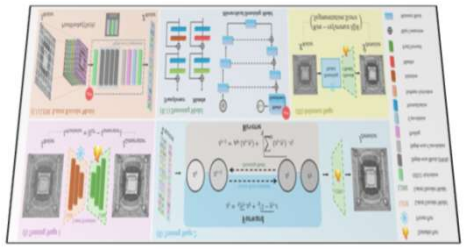
2 Generator signal





3 Denoise





No	Paper	Journal/Conference	IF
1	Image-enhanced generative model for industrial scanning acoustic super-resolution in non-destructive testing	Engineering Applications of Artificial Intelligence	8.0
2	Transformer-Based Super-Resolution Scanning Acoustic Imaging for Industrial Inspection	IEEE International Conference on Industrial Technology (ICIT)	-
3	GAN-Based Super-Resolution in Linear R-SAM Imaging for Enhanced Non-Destructive Semiconductor Measurement	Applied Sciences	2.5
4	Unsupervised Hybrid Transformer–Mamba Diffusion for Depth-Dependent Image Denoising in Scanning Acoustic Microscopy	IEEE Transaction on Industrial Informatic	9.9
5	DIPSAM: A Diffusion Inpainting Framework for Industrial Image Restoration in Scanning Acoustic Microscopy	Computers and Electrical Engineering	4.9

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Scanning Acoustic Microscopy – Super Resolution

❖ Methodology

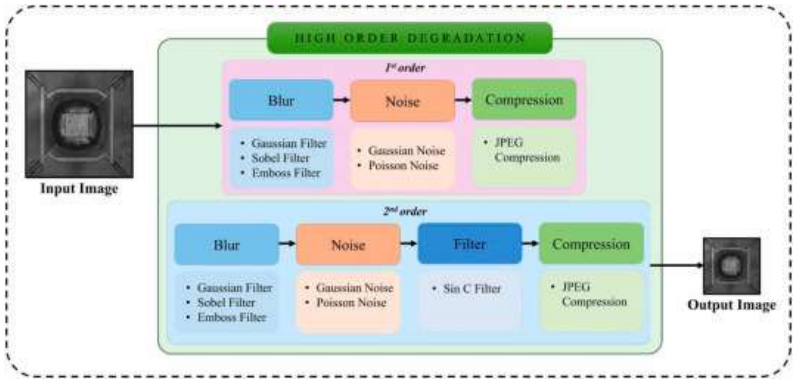


Fig. 1. Synthetic dataset generator process.

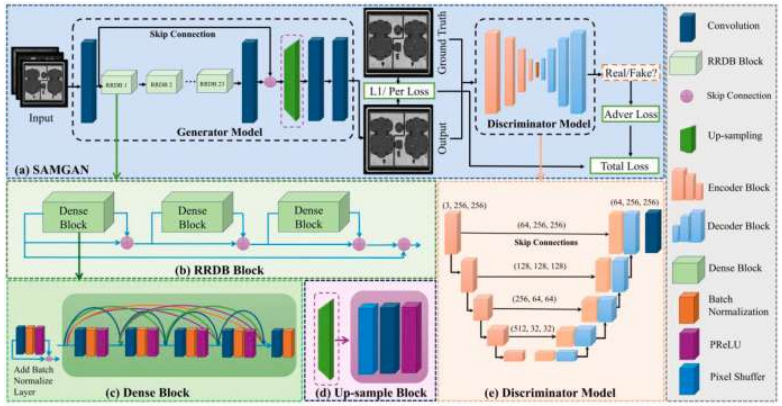


Fig. 2. Architecture of the proposed SAMGAN model.

❖ Result

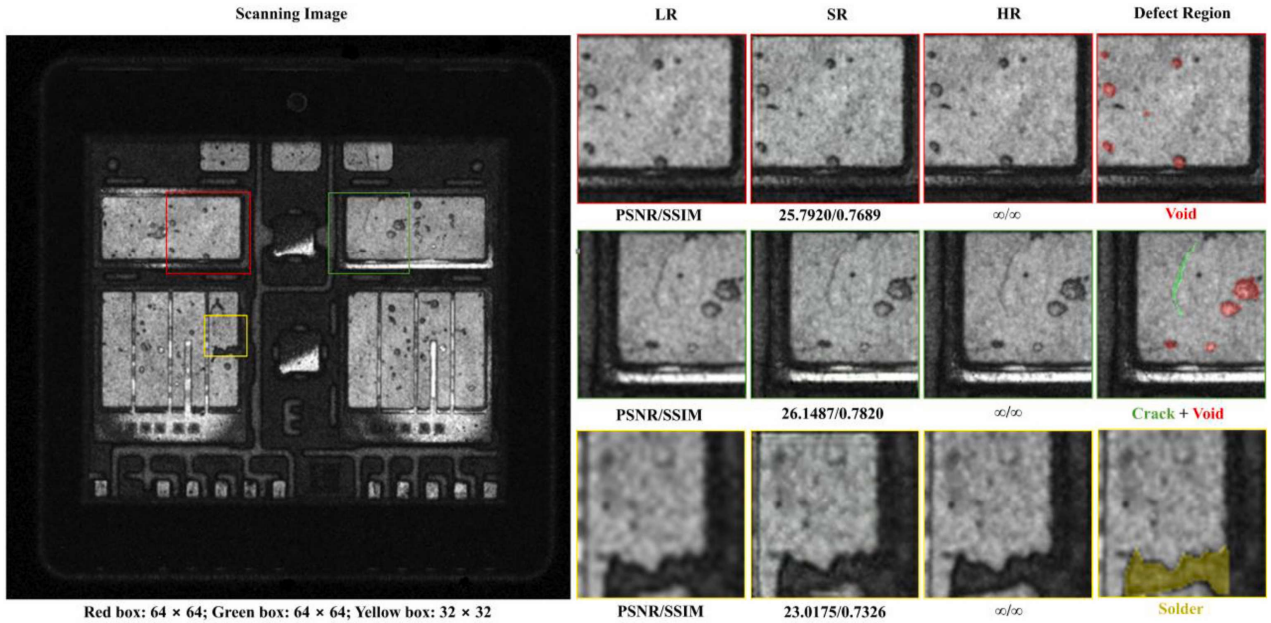


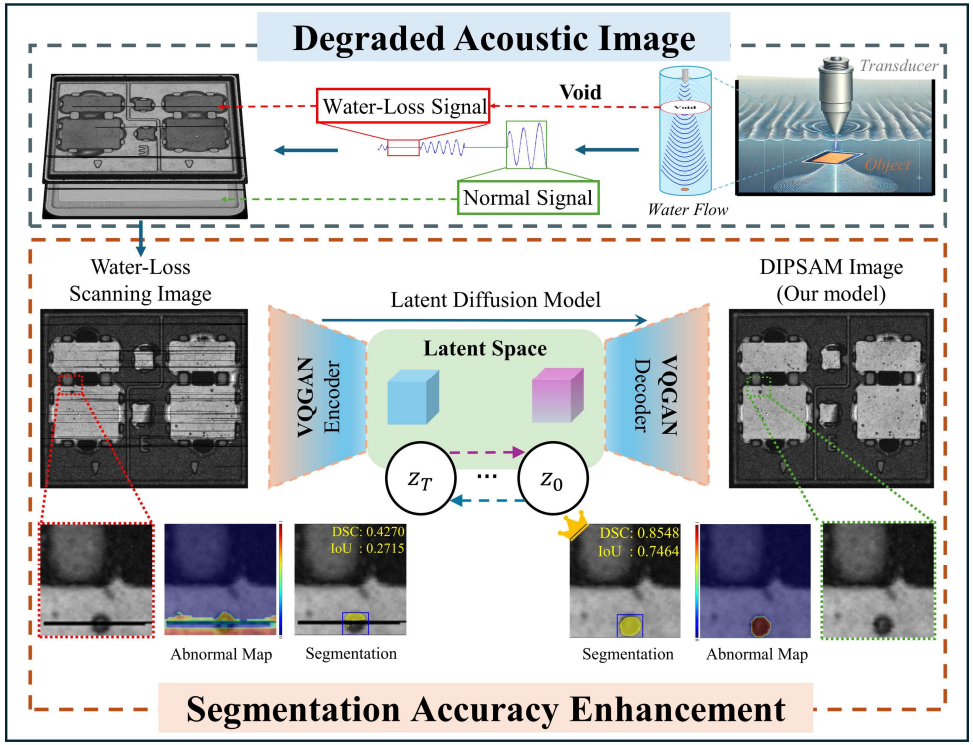
Fig. 3. The SR results on an industrial SAM image, including defect regions. Right-hand panels show zoomed-in patches of these regions. The zoomed-in regions consist of voids, cracks, and solder defects in the sample.

Conclusion:

- Enhances image quality for semiconductor industrial processes
- Improves inspection accuracy and effectiveness
- Detail for this paper, please scan it: 👉

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Scanning Acoustic Microscopy – Generator Signal



DIPSAM: A Diffusion Inpainting Framework for Industrial Image Restoration in Scanning Acoustic Microscopy

Conclusion:

- Reducing time and resource consumption, particularly in large-scale industrial inspections.
- These improvements directly translate to enhanced segmentation reliability.

❖ Methodology

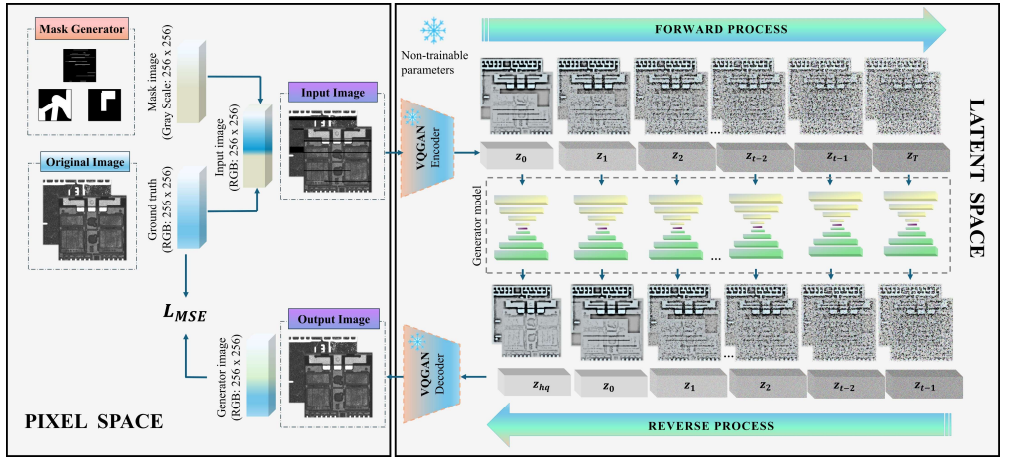


Figure 4: Overview of our proposed architecture

❖ Result

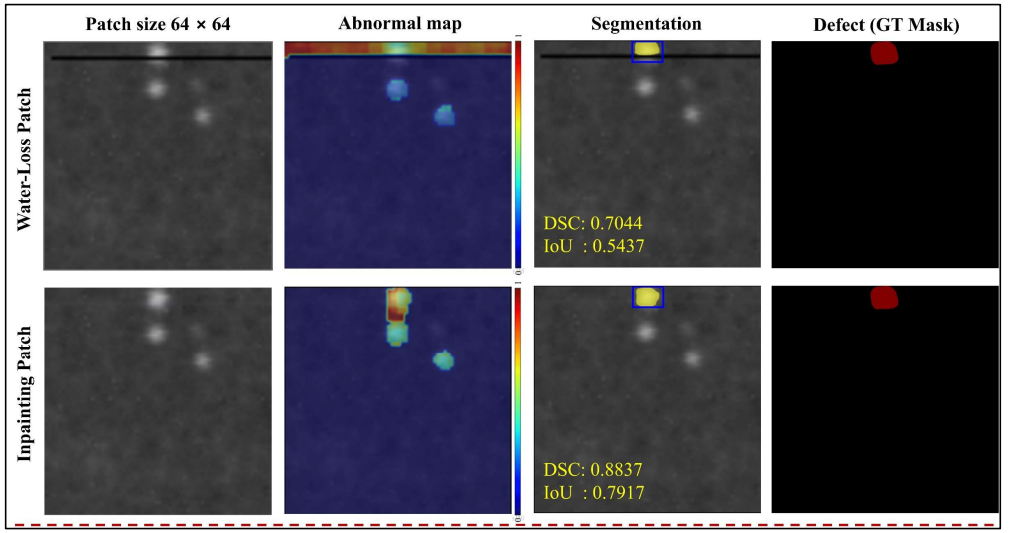


Figure 5: Comparison of segmentation performance and abnormal score maps before and after inpainting using the proposed DIPSAM model.

Scanning Acoustic Microscopy – Image Denoising

❖ Case study

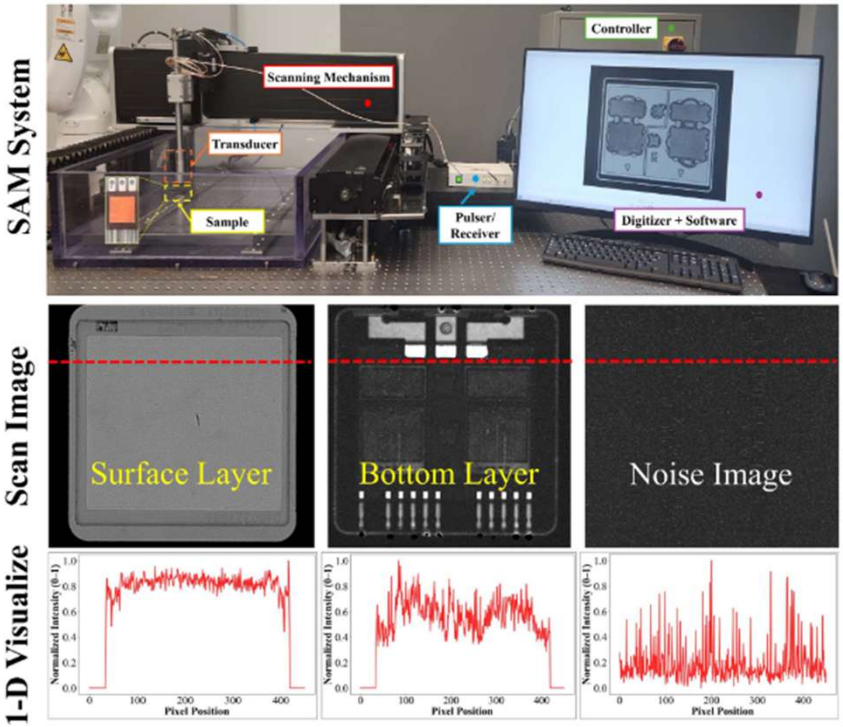


Fig. 6. SAM system and representative examples of noise characteristics. From left to right: scan images and 1-D normalized amplitude plots for the surface layer, bottom layer, and noise-only case. The results show stronger fluctuations and distortions at deeper layers and random background noise in the absence of a sample.

❖ Methodology

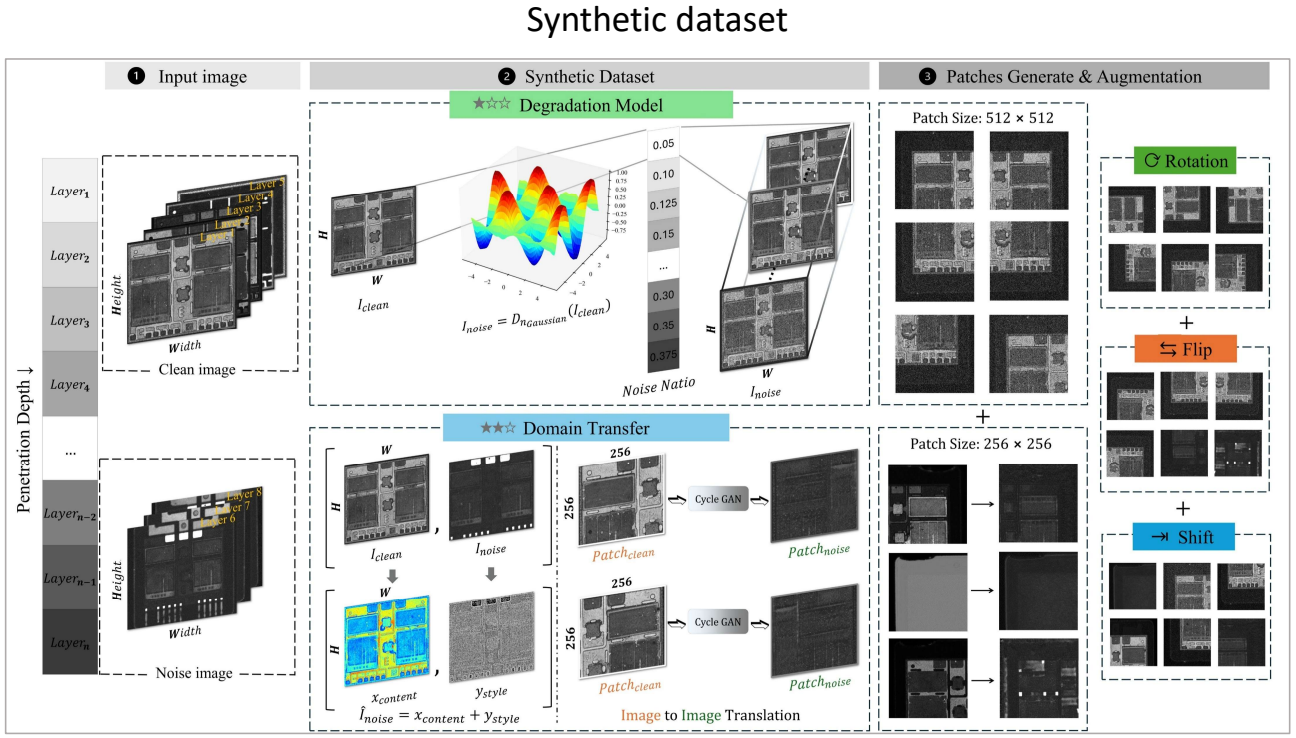


Fig. 7. Three-stage synthetic data generation pipeline for SAM denoising: 1) real acoustic images are captured from a commercial SAM system; 2) synthetic noisy images are created using a Gaussian DM and a Cycle GAN-based DT to mimic realistic depth-dependent industrial noise; and 3) clean and noisy images are segmented into fixed size patches and augmented for training. This pipeline alleviates data scarcity and improves robustness for industrial SAM denoising.

Scanning Acoustic Microscopy – Image Denoising

❖ Methodology

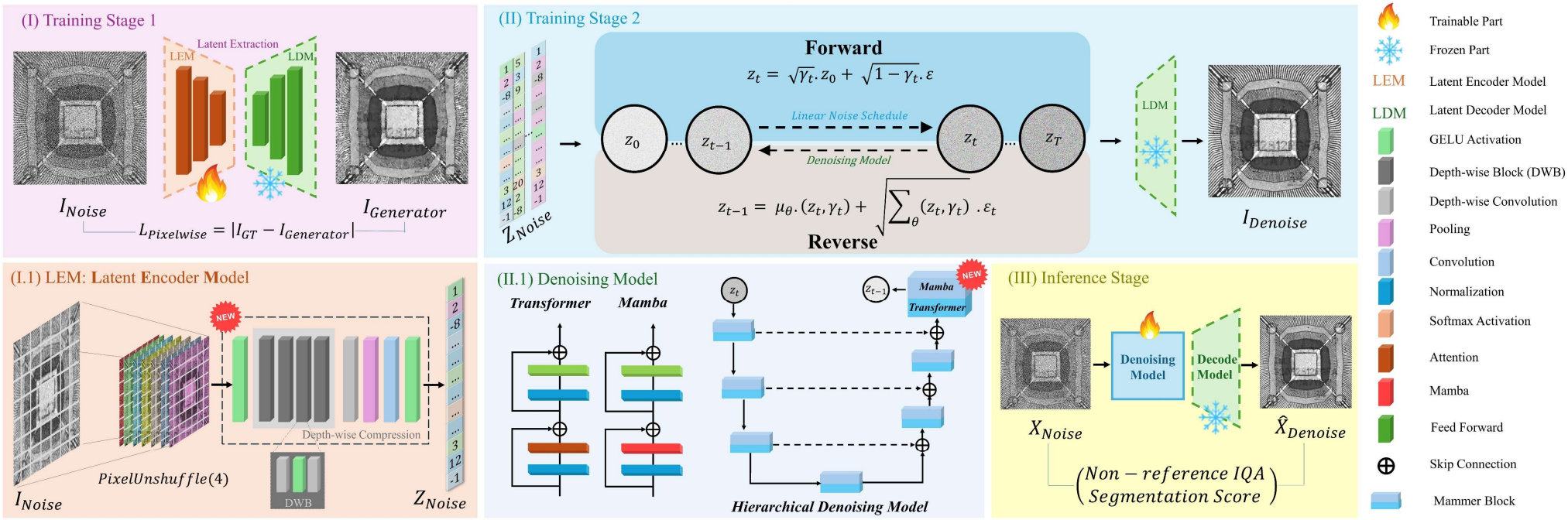


Fig. 8. Framework for denoising tasks using the proposed Mammer Block. (a) Training Stage 1 involves latent extraction with the latent encodermodel (LEM) and generation of noisy latent codes using a generator. (b) Training Stage 2 employs a forward process to add noise and a reverseprocess with the hierarchical denoising model, combining transformer and Mamba architectures. (c) Inference stage utilizes the trained denoisemodel to produce denoised outputs, evaluated with a nonreference IQA segmentation score.

Scanning Acoustic Microscopy – Image Denoising

❖ Result

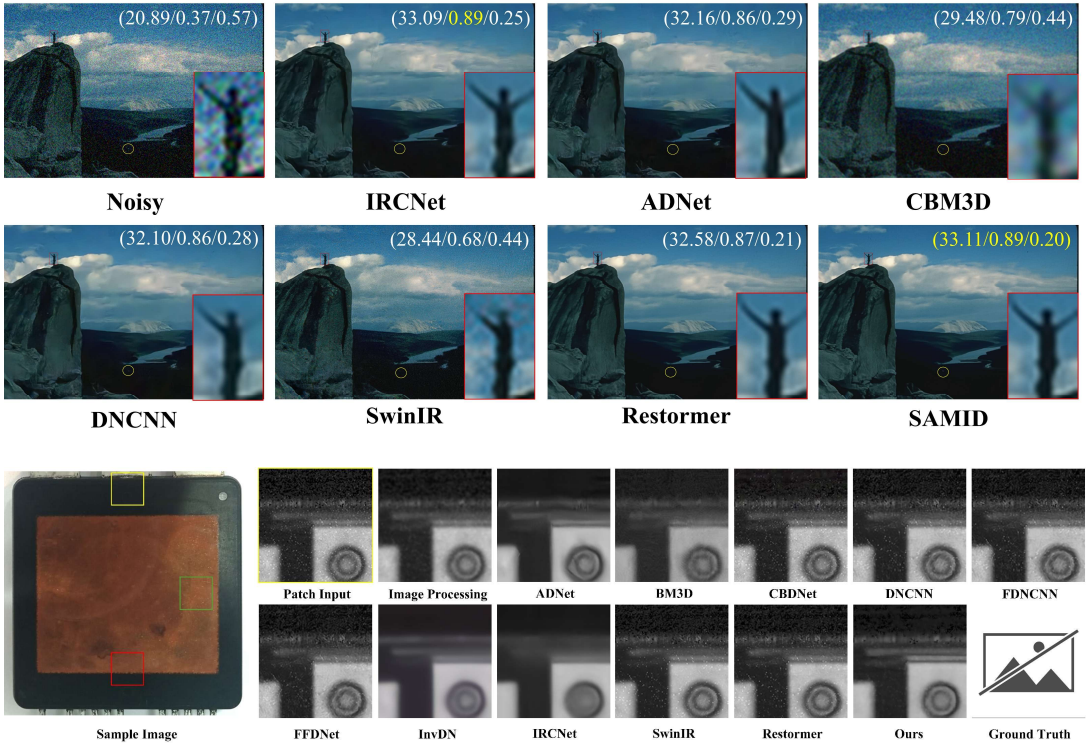


Fig. 9. Visual comparison of denoising results on benchmark dataset and industrial data from power semiconductor layers at noise ratios σ = 0.15 and σ = 0.25. Our model clearly preserves structural details and suppresses noise more effectively compared to other methods. Ground-truth (clean) images are included for reference.

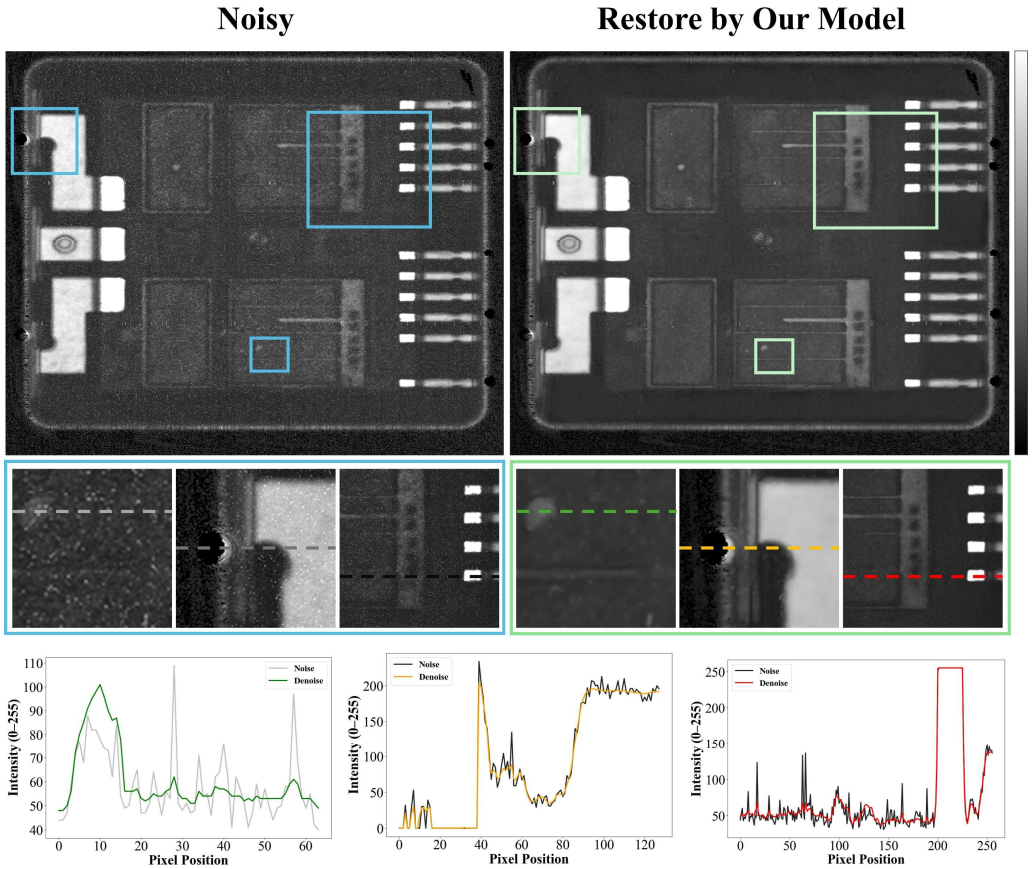


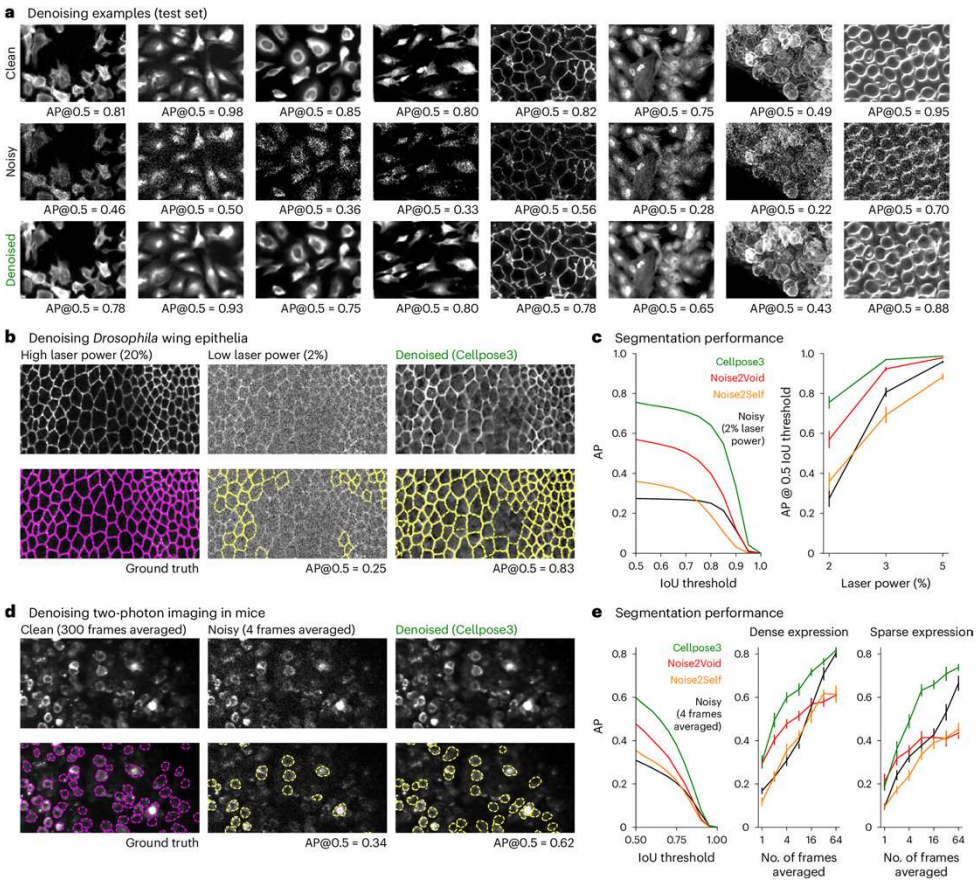
Fig. 10. Model effectiveness analysis.

- Paper: Unsupervised Hybrid Transformer–Mamba Diffusion for Depth-Dependent Image Denoising in Scanning Acoustic Microscopy
- More detail for this paper, please scan it

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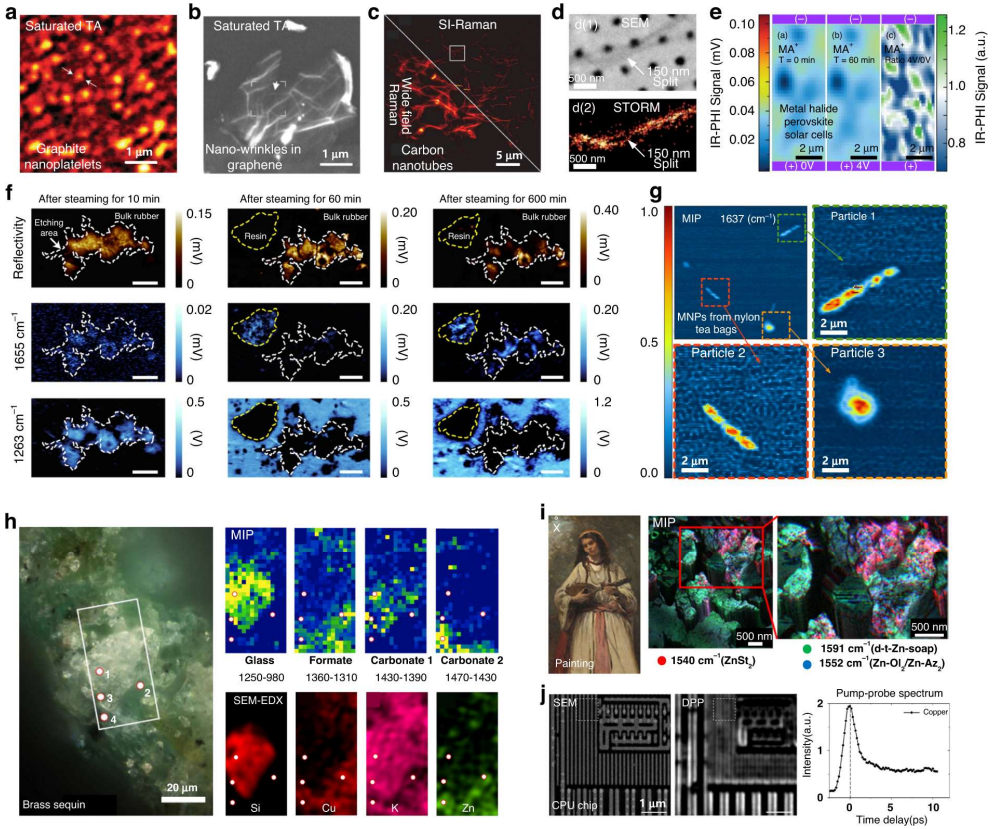
Image Restoration research – Another applications

❖ **Image restoration for improved cellular segmentation**

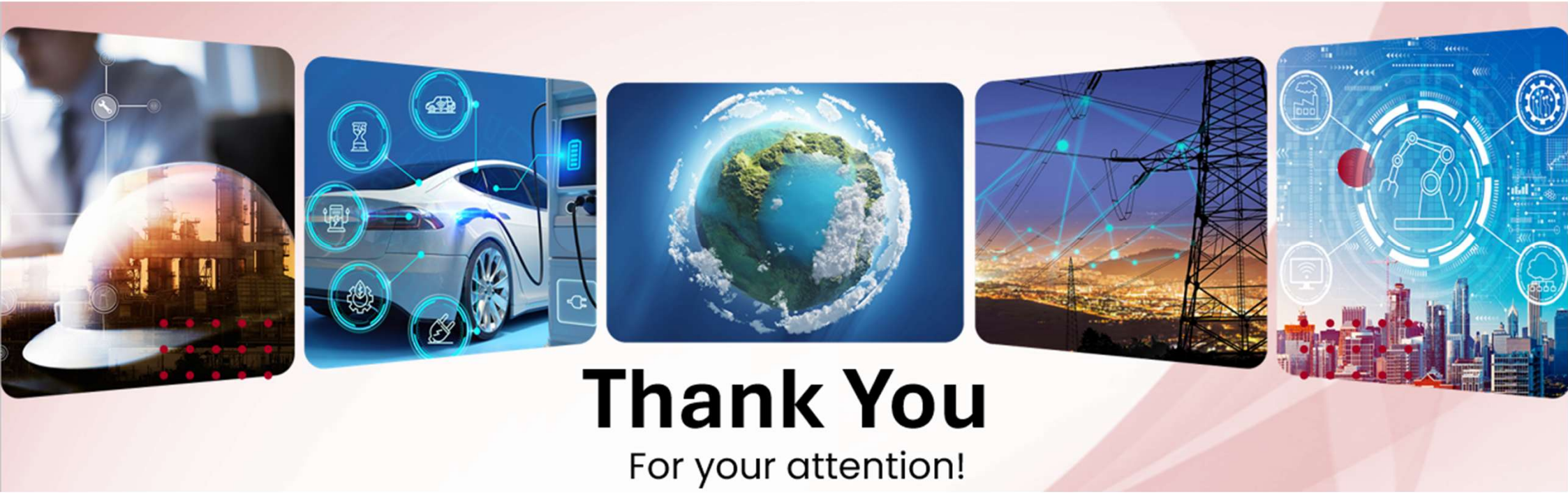


Source: https://doi.org/10.1038/s41592-025-02595-5, *Nat Methods* - Nature

❖ **Applications of super-resolution chemical microscopy in material science, environmental study, cultural heritage conservation, and chip inspection.**



Source: https://doi.org/10.1038/s41377-023-01182-7, *Light Sci Appl* - Nature



Thank You

For your attention!

- Thank the University, the Faculty, and the BK Program for their support in achieving these research results
- Thank Professor Junghwan Oh and the members of NBMLab for their support and collaboration.

Best regards,
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