

A Dataset of Cell Images Extracted from SEM Imaging Data for a Chip in 28nm CMOS Technology Node

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Data Collection

In this study, we have acquired integrated circuit (IC) scanning electron microscope (SEM) images (i.e., size of 1024×1224) from a backside thinned IC in 28nm complementary metal–oxide–semiconductor (CMOS) technology node. 115 sets of images have been collected through this process to build a useful research database for hardware assurance applications. In each set, there are three images captured from particular locations of the logical region of IC with three different dwelling times. The dwelling times are four ($3.2\mu\text{sec}/\text{pixel}$), five ($10\mu\text{sec}/\text{pixel}$), and six ($32\mu\text{sec}/\text{pixel}$).

In the released dataset, the provided IC SEM images are from the set 11 in the database, which are available in the “**SEM Image**” folder of the uploaded package. The extracted cell images can be found in the “**Extracted Cell**” folder. All the cell images are presented class-wise. The database of 115 image sets is released progressively that includes the IC SEM images along with the extracted cell samples.

Data Description

Each IC SEM image has the size of 1024×1224 in which there is an extra 200 pixels on the image width for storing the image metadata. All the IC SEM images are pre-processed before they are sent for cell extraction. According to our analysis, the images with the dwelling time of four (i.e., DT-4) include more noisy data than the other settings due to its low-pixel scanning time.

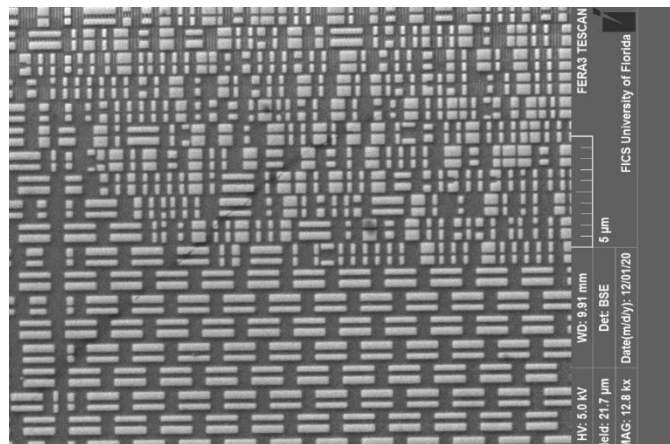


Figure 1: An IC SEM image in DT-6 from the dataset number 11.

The cell images have been extracted from IC SEM images using a method that is discussed in [1]. They are clustered class-wise and stored accordingly.




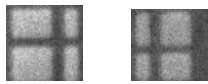
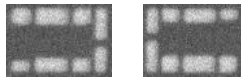



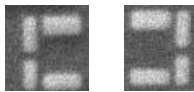

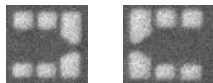

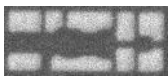
Identifier	Cell Image	Number of Images	Dwelling Time
0		735	Four ($3.2\mu\text{sec}/\text{pixel}$), Five ($10\mu\text{sec}/\text{pixel}$), and Six ($32\mu\text{sec}/\text{pixel}$)
1		957	
2		667	
3		297	
4		1634	
5		501	
6		2496	
7		126	
8		213	
9		18	
10		18	
11		81	
12		183	
Total		7926	

Table 1: The cell Images extracted from SEM images for a chip in 28nm CMOS technology node.

Currently, we have processed 50 number of IC SEM images and extracted around 7,926 number of cells that are clustered in 13 different categories, which are shown in Table 1. We have omitted the cell images that could cause redundancy rather than variety in the dataset. As an application of these extracted cell images, diversified synthetic samples have been produced using Mode-Seeking Generative Adversarial Network [1]. This database can be used in variant research studies in hardware security, especially for hardware Trojan detection. In our future releases, more image sets of extracted cells along with their synthetic versions will be provided.

References

[1] M. M. Al Hasan, N. Vashistha, S. Taheri, M. Tehranipoor, and N. Asadi, “Generative Adversarial Network for Integrated Circuits Physical Assurance Using Scanning Electron Microscopy” 2021 IEEE International Symposium on the Physical and Failure Analysis of Integrated Circuits (IPFA), 2021.