Measurement and Calculation Method for Sub-20 nm Line and DSA Patterns

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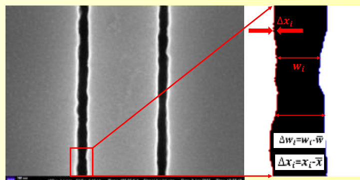
Outline

- Sub-20 nm metrology required for technical node below 10nm
- Quantitative measurements of line width roughness (LWR), line edge roughness (LER), and CD & pitch
- Defectivity measurement of DSA pattern, including fingerprint and line/space pattern on templates

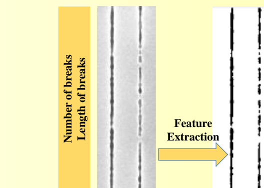
Method

All codes are completed in MATLAB R2021a environment

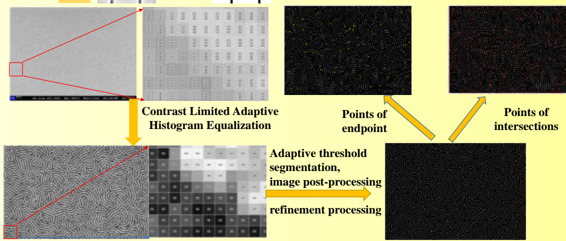


$$LER = 3\sqrt{\frac{\sum(\Delta x_i)^2}{N}} \qquad LWR = 3\sqrt{\frac{\sum(\Delta w_i)^2}{N}}$$

First intercept the SEM image containing the line segment region, then perform adaptive thresholding, use peak point detection to obtain the coordinates of the line segment boundary points, and finally calculate the LER,LWR using the equation above.



Adaptive threshold segmentation of the SEM image and refinement of the segmented image, the number of breaks is the number of connected areas minus the number of lines, the total break length of the line is the difference between the total length of the line and the length of the connected area.



CLANE was applied to the image to improve the image contrast. The following processes consisted of adaptive threshold segmentation, image post-processing and refinement successively. Finally, the end points and the intersecting feature points are extracted.

RESULTS

A Line width and roughness results

Result / Line(nm)	LWR	LER_R	LER_L	Line Width	Gap Width
Line -left	1.72	1.16	1.20	374.04	16.04
Line -right	2.13	1.19	2.19		19.13
Mean	1.93±0.29	1.44±0.51		374.04	17.58±1.55

B. Line Pattern Quantitative Analysis Results

Pattern	Number of breaks	Beak length
Pattern_1	1	5.582nm
Pattern_2	26	480.052nm

C. Extract endpoints and intersections of images

Length of connected region	Total number of intersection and endpoint
82736.4nm	299

Conclusion： The CLANE method proposed by the algorithm in this paper can significantly improve the contrast of the pattern for fingerprint images, and the overall algorithm can quickly determine the desired results.

Reference

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3. M. S. Hitam, E. A. Awalludin, W. N. Jawahir Hj Wan Yussof and Z. Bachok, "Mixture contrast limited adaptive histogram equalization for underwater image enhancement," 2013 International Conference on Computer Applications Technology (ICCAT), 2013, pp. 1-5, doi: 10.1109/ICCAT.2013.6522017.